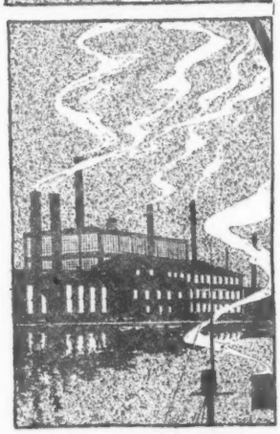
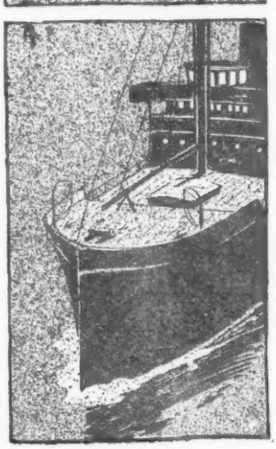
POWER

Vol. 44 NEW YORK, JULY 25, 1916 No. 4

The Mission of Steam





By Berton Braley

Wherever the fires are agleam
And banners of smoke are unfurled,
Wherever the factories teem
Or shaft of an engine is whirled,
This is the mission of steam—
To lighten the toil of the world!

To lift from the secret recesses deep down in the bowels of earth
The treasures that nature has hidden—and make them the riches of man;
To carry the harvest of plenty to places of want and of dearth,
To batter a way through the mountains and make of the seas but a span;
To fill all the world with enchantments of iron and copper and steel
And fashion strange engines of magic that climb to the vault of the sky;
To scatter the mists of tradition to trample all doubts under heel,
To prove the impossible, simple, and show that "I can't" is a lie!

What matter if men use this power to build them grim monsters that slay?
What matter if men in their blindness misuse all this marvelous might?
They shall learn in good time of their error and mourn it for many a day,
They shall use the huge labor of steam to bring them again to the light.
Too long has it served for oppression, for binding the serf to his toil,
Too long has it fettered the worker to labor with never a thrill;
But in time it shall raise us from plodders, who fret and who sweat and who moil,
To masters of fate and of fortune, who conquer the world by their skill.
It shall bring us more wonder and beauty, more justice and mercy and truth,
It shall lift from the shoulders of drudges the burdens they've borne overlong;
It shall bring their sweet rest to the aged and serve for the visions of youth,
It shall make man ruler of destiny, dominant, happy and strong!

To break all the fetters that irk,
To set all the darkness agleam,
To answer all doubts that may lurk,
By making a Fact of the Dream;
This is the goal of its work,
This is the mission of steam!

Power System of the Syracuse Lighting Co.

By Norman G. Meade

SYNOPSIS—This company has one main generating station at Fulton St., herein described, and several substations, which are operated in conjunction with power purchased from the Niagara, Lockport & Ontario Power Co.

In most large or medium-sized cities are to be found two or three systems of distribution for lighting and power. As a rule, some direct current for power purposes is still used in the business districts, and both 25- and 60-cycle alternating-current circuits. In addition series arc lighting, both direct and alternating current, is used to a large extent. The transition from the old to modern systems calls for a rather diversified power-plant equipment, as it is not generally feasible to eliminate entirely the older sections of the system. Another feature to be considered in some sections is hydro-electric power in conjunction with existing steam-generating stations. In central and western New York the Niagara, Lockport & Ontario Power Co. supplies power to local lighting and power companies, of which the Syracuse Lighting Co. is an example. This company operates a large steam-generating station and several substations, and its service includes 500-volt direct-current power distribution, 2,300-volt three-phase 25-cycle and 60-cycle light and power mains, 2,300-volt single-phase 60-cycle lighting service, and series arc and incandescent lighting for street illumination.

Present Plants of the Company

At present the company operates the Fulton Street generating station, the Liberty Street substation, and the Solvay transformer substation, four miles west of the city where connection is made to the transmission lines of the Niagara, Lockport & Ontario Power Co. and several smaller customers' stations. The Solvay substation contains two banks of three 1,000 kv.a. transformers, connected star-delta, which reduce the transmission-line voltage from 60,000 to 11,000 volts, three-phase 25-cycle; one spare transformer is provided. The 11,000-volt feeders from this substation connect with the Fulton Street generating station, the Liberty Street substation and Camillus, a small town west of Syracuse. In the Fulton Street power house, aside from the steam generating units, there are frequency changers, motor-generators and series regulating transformers for serving the different distribution systems.

Extensive additions are now being made to the system. A new switchhouse is in course of erection at the Fulton Street power house, which will take care of the future feeders from Solvay, and the switchhouse bus will tie in with the present bus structure in the power station, where a control benchboard in two sections will be added in an extension to the present switchboard gallery. There is also in course of erection an addition to the Solvay substation and a large substation on East Fayette St. in the city; these will be described later.

In the Fulton Street station steam is furnished by eighteen 350-hp. and two 650-hp. water-tube boilers, the latter double-ended. Nine of the former and the two larger units are equipped with side-feed stokers, the remaining nine being arranged for oil burning or coal with hand firing. Natural draft is used under ordinary conditions, although a blower equipment is installed for use in emergency. Each boiler is fitted with an automatic nonreturn valve and an 8-in. gate valve. Besides, there is an 8-in. valve at each lead to the header, which is 14 in. in diameter. The latter has three crossovers and 14-in. gate valves between groups of three boilers.

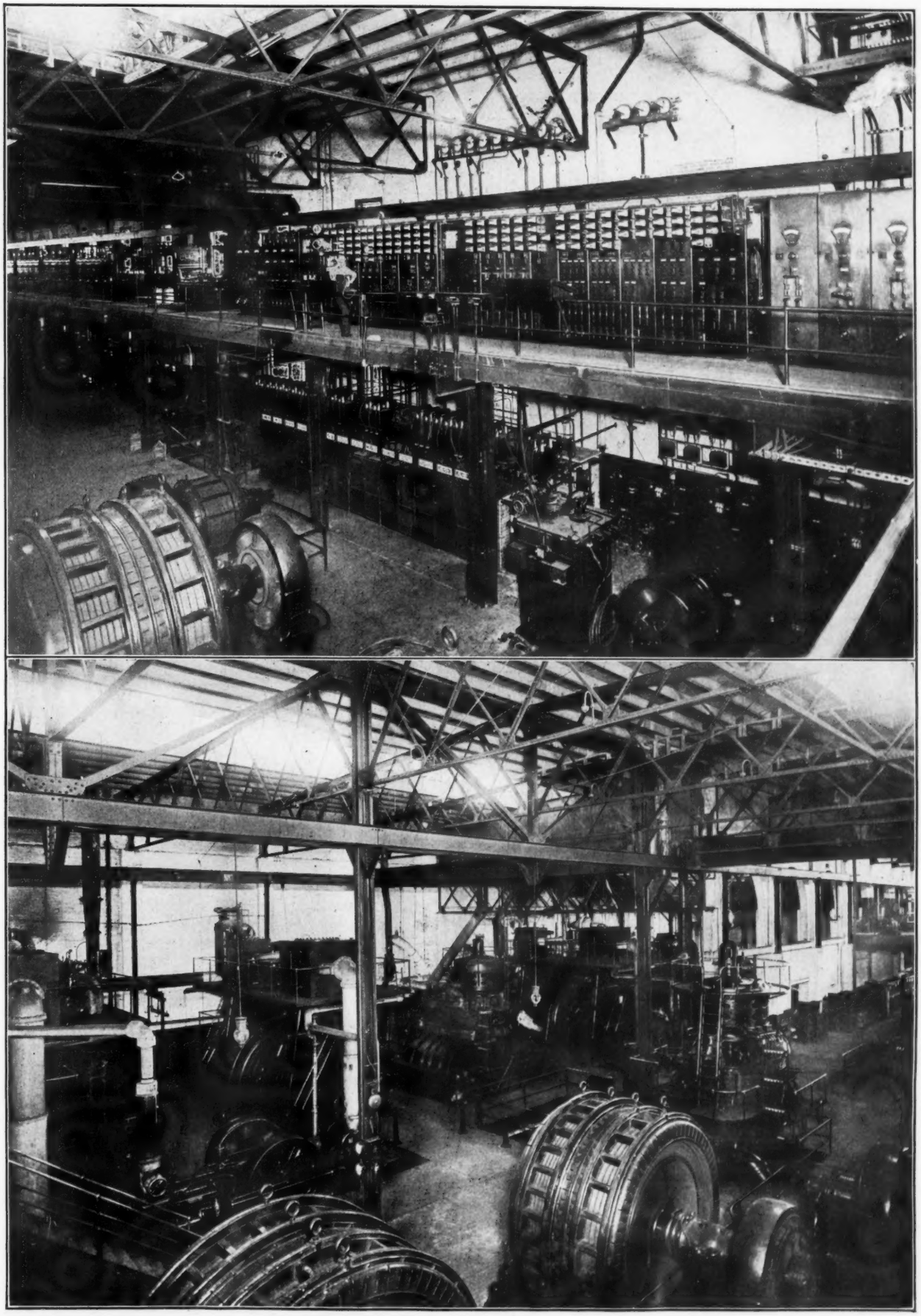
There is a 5,000-hp. open feed-water heater. Feed water is taken from the Oswego canal, city water being used when the canal is drawn for inspection. Water is pumped from the hotwell to the heater by a 16x8x14-in. direct-acting pump and from the hotwell to the water-treating system by two 12x7x12-in. pumps. A Holly gravity system returns the drips from the steam traps to the boilers.

Slack Used for Fuel

Westmoreland slack is used for fuel. This is received in cars on a siding where it is dumped into hoppers beneath the tracks. It is then elevated by a 90-ft. belt conveyor and either deposited in the 12,000-ton storage yard or in the boiler-room bins by a second conveyor, which receives the coal from the first. In the storage yard there is a 10-ton electric jib crane, with a capacity of 50 tons an hour, operating on a circular track.

The generating units include both turbines and reciprocating engines. There is a 5,000-kw. 2,300-volt three-phase 60-cycle turbo-generator served by a LeBlanc condenser, the air and discharge pumps of which are driven directly by a single-stage steam turbine. For priming the condenser a 2-in. pipe perforated with ⅛-in. holes is inserted in the discharge from the turbine. The water for this purpose is taken from a coil in the base of the turbine for oil cooling. This water is also previously used for cooling the transformers. In order to be able to start up the turbine at short notice, it is kept hot while idle by steam admitted through a ½-in. pipe extending around the throttle close to the U-bend. When the machine is not in service, the valve in this pipe is kept half open. There was formerly trouble with scale in the water-seal glands on both the high-pressure and the low-pressure ends, but at present water is circulated through the seals from two tanks which receive the discharge from the heating system, and the scale is thus practically eliminated. All purchased water used in the condenser air pump is discharged into a 7,000 gal. tank and is used repeatedly. The air intake for the turbine extends from the roof to the machine, the air passing through dust screens and discharging from the upper side of the turbine case.

There are two smaller turbines of the vertical type driving three-phase 1,500-kw. 2,300-volt generators. Both are served by surface condensers. The circulating



UPPER VIEW SHOWS SWITCHBOARD AT FULTON STREET STATION; LOWER VIEW SHOWS THE GENERATING UNITS AT SAME STATION

pump for each is rated at 4,000 gal. per min. and is driven by a 60-hp. induction motor. One of the turbines has an oil step bearing and the other a water step bearing.

There are three vertical reciprocating units, each consisting of a 23x30x46-in. cross-compound engine driving a 1,115-volt three-phase 60-cycle alternator. The engines are run condensing and are served by Blake condensers.

The 500-volt direct-current system is supplied by a horizontal cross-compound 23x30x46-in. engine driving an 850-kw. 500-volt generator at 120 r.p.m., and by two motor-generator sets each consisting of a 700-hp. 11,000-volt 25-cycle three-phase induction motor and a 500-volt direct-current generator.

To supply the 2,300-volt 60-cycle three-phase distribution system, in addition to the steam-driven units there are three frequency changers, each rated at 1,000 kv-a. and consisting of an 11,000-volt 25-cycle motor and a 2,300-volt 60-cycle generator. The exciters for these sets, which are also used for starting purposes, are 125-volt direct-current machines rated at 600 amp. Starting current is furnished by a 100-kw. 125-volt direct-current generator driven by a simple engine. Current to the arc-lighting circuits is supplied by three 50-light 4-amp. G. E. Brush-type series arc generators. Two of these machines are directly driven as a pair by a 150-hp. 2,300-volt induction motor, and the third is belt-driven by a 75-hp. motor. In addition to the arc generators there are 18 double 100-light series regulating transformers with mercury rectifiers for 4-amp. magnetite arc lamps, and eight 25-kw. 1,100-volt 7½-amp. series regulating transformers for ornamental pole lighting. The 2,300-volt single-phase feeders tap from the 2,300-volt three-phase, busbars. There are seven single-phase regulators supplying 10 single-phase feeder circuits in the subway. There are also five three-phase regulators for the 2,300-volt three-phase 25-cycle feeders—one in the subway and four overhead. One spare regulator, which can be operated three-phase or single-phase, 25 or 60 cycle is held in reserve for emergency use.

The switchboards are in a gallery overlooking the engine room and consist of 3 generator and 4 feeder panels for the 500-volt direct-current system with 4 overhead and 4 subway feeders; 18 arc-light panels; 8 panels for ornamental lighting circuits; 9 panels for generators and transmission lines; 5 panels for 11,000-volt 25-cycle and 2,300-volt 60-cycle single- and three-phase feeders; 7 exciter panels; 1 Tirrill regulator panel; 2 panels for storage battery and motor-generator sets, and 1 totalizing panel. The storage battery consists of 54 cells and is used for switchboard work and the operation of oil switches.

There is an automatic arrangement for equalizing the load between the steam and water power, consisting of a motor attached to the turbine governors and actuated by a relay connected to the generator mains and the transmission lines.

For cleaning the machinery by compressed air there is an 8x7x8-in. motor-driven air compressor. A gravity oiling system is provided for all reciprocating units and a small duplex pump circulates the oil from the filter to the storage tanks.

In the addition to the present Solvay substation equipment, there will be installed a bank of three 60,000/11,000-volt, star-delta-connected 3,000-kv.-a. transformers, with a fourth transformer of the same capacity and characteristics held in reserve. Provision will be made for two duplicate banks of transformers. There will at first be one 11,000-volt feeder to the Fulton Street switchhouse and two feeders to the new West Fayette Street substation. Provision will be made for seven future feeders. The bus structure is composed of concrete and alberine stone, and the transformers will

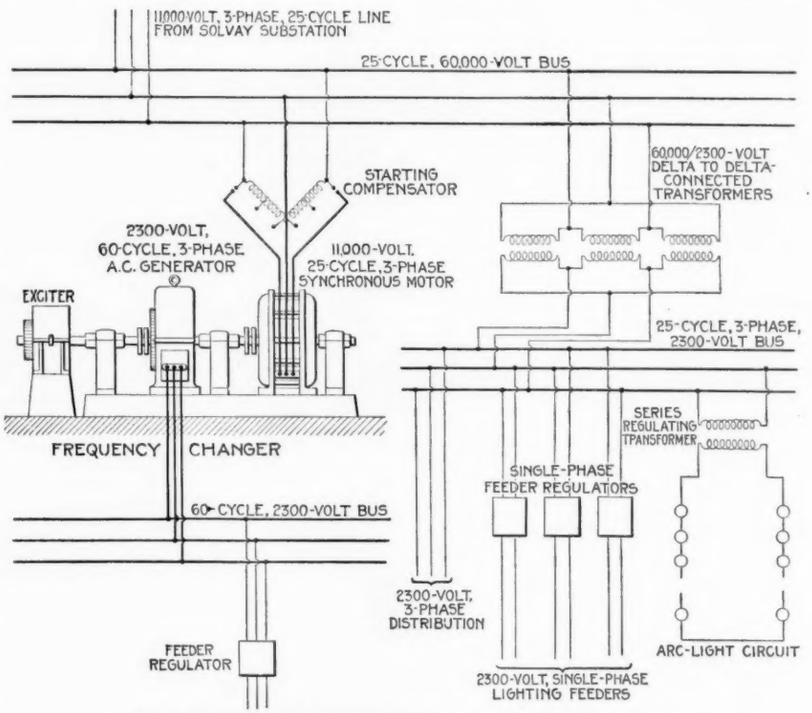


DIAGRAM OF CIRCUITS, WEST FAYETTE STATION

be in individual brick cells. There are two 60,000-volt oil switches outside the building, one for the new and one for the old outdoor bus structure. Limiting reactances are connected in the 11,000-volt feeders. Circulating water for the transformers is handled by two 4-in. centrifugal volute-type pumps. All the transformer cells open outward, and the transformers can be rolled outside of the building on their wheel trucks and deposited on a carriage running on rails adjacent to the building. Any unit can then be placed under a hoist at the end of the bus structure.

In the new West Fayette St. substation the equipment will include transformers, frequency changers and series regulating transformers. Part of the latter will be transferred from the Fulton Street power house. The station will be fed by two 11,000-volt lines from Solvay and with a feeder tapped to one of the present overhead feeders running between the Fulton Street station and Solvay. Provision has been made for three future incoming lines. The frequency-changer installation will consist of three 3,000-kv.-a. units 25-cycle

11,000 volts to 60-cycle 2,300 volts. Unlike the Fulton Street station, these will be started direct from the alternating-current lines through starting compensators. There will be an equipment of series regulating transformers for thirteen 50-light arc circuits with provisions for eleven additional circuits.

The present installation of feeder regulators will consist of two three-phase 60-cycle 300-amp. machines for general distribution and three single-phase regulators for the 2,300-volt single-phase lighting circuits with provision for six future units. The 25-cycle 2,300-volt three-phase distribution will be fed from delta-connected transformer banks. There will be two present circuits and provision for five future circuits with two future transformer banks. The arc-light distribution will be overhead as well as the 2,300-volt feeders.

Effects of Eddy Currents

By W. N. Cross

SYNOPSIS—How eddy currents are produced, their damping effect on meters, how they may be minimized and the calculation of eddy-current losses.

Eddy, or Foucault, currents are those which are induced in a mass of metal whenever it is moved in a magnetic field, or when a field, or flux, moves through the metal. These currents are always in such a direction as to oppose the motion producing them (Lenz's law). Eddy currents are usually of relatively small intensity, but may be enormous; and they always involve an I^2R loss which in the aggregate may be considerable.

If a permanent magnet be rotated close to and above a metal plate, as in Fig. 1, eddy currents will be induced in the plate. Some of the flux of the magnet cuts the metal of the plate and thereby induces an electromotive force which impels these currents around in the plate. Under these conditions considerably more force will be required to rotate the magnet than if the plate were not near it, because the induced eddy currents tend to retard the rotation of the magnet. Now if the magnet be held stationary and the plate revolved, eddy currents will also be induced in the plate. If the magnet is not restrained, it will tend to rotate, following the plate. The direction of the eddy currents with the plate rotating to the left is shown. Part of the current follows its own approximately semicircular path in the plate at one side of the magnet; the rest follows a similar path at the other side of the magnet. These two currents produce two magnetic poles, as shown. The polarities of these are such that they repel the nearest (in the direction of rotation) pole of the permanent magnet. Thus rotation is opposed and the requirement of Lenz's law is satisfied.

If the magnet is not restrained, it will try to assume such a position that, as the plate rotates, its north pole will lie directly over the south pole of the plate and its south pole over the plate's north pole. It can never attain this position, however, because if the magnet moves, the position of the poles of the plate will shift also. Each of the halves of the plate will always be oppositely polarized, the magnet, as it were, dividing the plate into halves. If the magnet is prevented from turning, the plate rotated, and a light metal wiper, or brush, is arranged to bear on the plate under each magnet pole, current will be forced through an external circuit connected to the brushes, as will be indicated by a low-reading ammeter connected in the circuit.

*Copyrighted.

Suppose that a slab of copper be abruptly pushed into the field between the poles of a strong electromagnet, the copper acts as if it were being moved in a heavy fluid. The eddy currents induced in it tend to prevent its movement. Also if a copper penny be suspended on a twisted thread between the poles of a powerful magnet, as in Fig. 2, or in any strong electromagnetic field, the penny will spin as the thread untwists, provided the magnet is not energized; but when it is energized, the motion will be retarded. The eddy currents in the metal bobbins of the moving elements of permanent-magnet-type direct-current measuring instruments, and of the D'Arsonval galvanometer, tend to stop their motion. The bobbins are suspended in strong magnetic

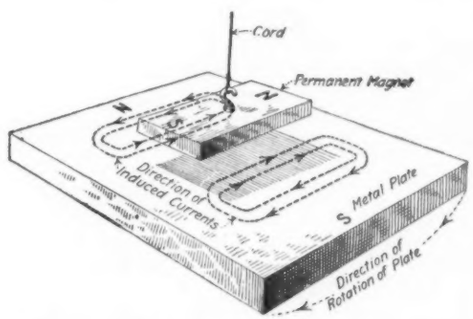


FIG. 1. EDDY CURRENTS INDUCED IN A METAL PLATE

fields, and when they move, eddy currents develop. It is because of this that these instruments are "dead-beat."

Furthermore, the needle of a compass will come to rest much more quickly if it be mounted in a metal case than if it is in a nonconducting case, because of the eddy-current action.

An important illustration is the application of damping magnets to a watt-hour-meter movement (see Fig. 3). These damping magnets, because of the eddy currents due to them, perform two important functions: (1) They prevent an excessively rapid rotation of the moving element of the meter; (2) they insure that the rotational speed of the disk will always be proportional to the load that is being metered. The metal disk, usually of aluminum so that the weight of the rotating element will be a minimum, is mounted on a vertical steel shaft between the poles of strong permanent magnets. As the disk is forced to rotate by the small electric-motor movement (not shown), eddy currents are induced in it. These, in accordance with Lenz's law, tend to retard the rotation of the disk. The meter motor is

actuated by the voltage impressed on, and the current taken by, the load being metered.

If a watt-hour meter is to register correctly, its moving element must at any instant rotate at a speed exactly proportional to the power load being metered at that instant. Now every meter motor is so designed that the torque which it develops at any instant is proportional to the load (power) being metered at that instant. If the load is doubled, the meter motor torque is doubled; if the load is halved, the motor torque is halved.

It is this motor torque that forces the moving element to rotate. If the damping magnets were not provided, a meter would, even when metering a very light load, rotate at an exceedingly high speed, because then the only counter-torque opposing the rotation of the motor would be that due to the friction and windage of the rotating element and the meter movement. In practice this friction and windage is very small, particularly at low speeds. The high speeds that would thus result would be undesirable mechanically. Furthermore, it can be shown that these high speeds would not necessarily be directly proportional to the power loads that are being metered by the instrument.

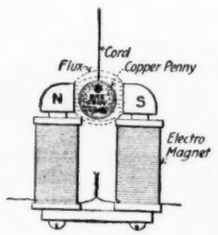


Fig. 2

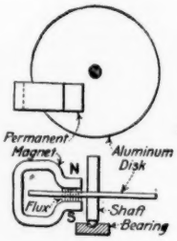


Fig. 3

FIGS. 2 AND 3. MAGNETIC DAMPING

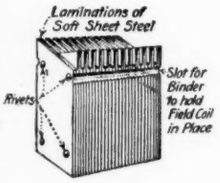


Fig. 4

FIG. 4. POLEPIECE

If the speed of the meter motor is to be exactly proportional to the load being metered, it is imperative that the total counter-torque must vary exactly with the speed of rotation. Since the flux of the permanent magnets (Fig. 3) is constant, the intensity of the eddy currents induced is proportional to the speed of rotation of the disk. Therefore the damping, or counter-torque, effect varies directly as the speed of rotation.

How this phenomenon insures a rotational speed exactly proportional to the power load being metered can be best illustrated by an example: Assume that with some certain load an imaginary meter motor develops a torque of 1 oz. at 1 in. radius. Then the counter-torque due to the damping magnets would necessarily also be 1 oz. at 1 in. radius. (The almost negligible friction-and-windage counter-torque is here disregarded.) This is evident because any magnet-damped motor will always rotate at a speed such that the eddy-current counter-torque is equal to the motor torque. Now assume that the load being metered is doubled. The meter motor would develop a torque twice as great as before, or 2 oz. at 1 in. radius. Since its torque has now been increased, the motor will speed up until it acquires a speed such that an eddy-current counter-torque is developed equal to the new motor torque. That is, it will speed up until its rotational speed is such that the new counter-torque is 2 oz. at 1 in. radius.

The so-called medical induction coils, or "shocking coils," have cylindrical brass tubes that can be moved in and out between the windings of the coil. When the tube is all in and entirely surrounds the core, the secondary e.m.f.—that is, the "shocking effect"—of the coil is small. The secondary e.m.f. increases as the tube is withdrawn and is a maximum when the tube is entirely withdrawn. The explanation is that when the tube is all in, the eddy currents in it are considerable, consequently the core magnetizes and demagnetizes slowly and the e.m.f. induced in the secondary is low. But when the tube is all out, the eddy-current losses are practically eliminated, the core magnetizes and demagnetizes rapidly and the secondary e.m.f. is high.

Minimizing Eddy-Current Loss

Since an eddy current tends to flow at right angles to the direction of the flux, the resistance of its path and the intensity of its e.m.f. can be decreased by laminating the metals in which it tends to flow, as in Fig. 6. The laminations should lie parallel to the direction of the flux and at right angles to the axis of rotation. Since the eddy-current loss varies as the square of the thickness of the laminations, it is possible to greatly reduce the loss by this construction.

In commercial electrical apparatus all large volumes of metal that are subject to considerable eddy-current loss are laminated; that is, they are built up of thin sheets of metal, usually from 0.01 to 0.03 in. thick. Thicker sheets may be used where the tendency toward eddy-current loss is not great. The sheets are usually painted to provide insulation between them, but in some cases the oxide on the metal provides sufficient insulation against the eddy currents.

The cores of spark and induction coils are built up of lengths of iron wire to minimize eddy-current loss. An electromagnet composed of an insulated conductor wound on a solid iron core may require 10 or 12 times as long to magnetize as a magnet of exactly the same proportions but having a "laminated" core consisting of a bundle of iron wires. The magnet with the solid core will also demagnetize much more slowly than the other. Fig. 4 shows how the field-magnet core of a certain type of generator is laminated to minimize eddy-current losses.

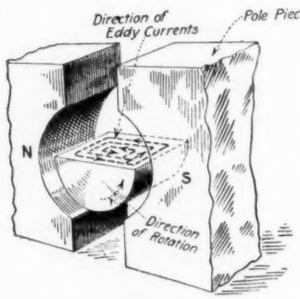


FIG. 5. EDDY CURRENTS IN ARMATURE CORE

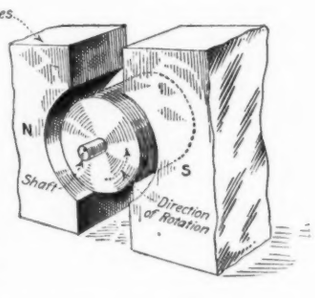


FIG. 6. SHOWING LAMINATED ARMATURE CORE

Wherever eddy currents flow there is an eddy-current loss, which appears as useless heat. Even when these losses have been minimized in so far as is practicable by laminating, they are considerable in generators, motors, transformers and similar apparatus.

When the rotor of an electrical machine revolves in its field, there is a tendency to set up eddy currents (see Fig. 5). There is also a tendency toward the set-

ting up of eddy currents in the stationary parts, as flux sweeps through or changes in them. Applying the hand rule, it will be found that the eddy currents tend to flow in the cylinder in the directions indicated.

The eddy-current loss in any volume of metal that cuts, or is cut by, a flux must obviously depend, among other things, on the specific resistance of the metal and the rate at which the flux cuts the metal. Laminations increase the resistance and the thinner the laminations the less the eddy-current loss. A formula, the derivation of which cannot be given here, for computing eddy-current loss is as follows:

$$Pe = 0.254 \times j \times v \ (X \times f \times B)^2$$

where Pe is eddy-current loss in watts and j is a coefficient varying with the quality and kind of metal in which the currents are induced, the following values being given in Pender's "American Handbook for Electrical Engineers," p. 907.

For silicon sheet steel, j varies from 0.000043 to 0.000098, with an average of 0.000065; and for ordinary electrical sheet steel j varies from 0.00012 to 0.00025, with an average of 0.00022; V is the volume of the metal in which the loss occurs, in cu.in.; X the thickness of the sheets in inches; f the frequency in cycles per second and B the maximum flux density in kilolines (thousands of lines) per sq.in.

Example: What eddy-current loss may be expected in a mass of ordinary laminated electrical steel having a volume of 61 cu.in. if the iron is acted upon by a flux (maximum) of 15,500 lines per square inch, at a frequency of 60 cycles per second? The laminations are 0.016 in. thick.

Solution: Substitute in the formula,

$$Pe = 0.254 \times j \times V \times (X \times f \times B)^2$$
$$= 0.254 \times 0.00022 \times 61(0.016 \times 60 \times 15.5)^2$$
$$= 0.0034 \times (15.5 \times 15.5) = 0.817 \ watt$$

Indicating the Ammonia Compressor--IV*

By Robert H. Karl†

SYNOPSIS—Illustrates diagrams from many compressors troubled with defective suction and discharge valves.

Fig. 18 was taken from a compressor in which the valves and the springs of all the valves were too weak and loose. This is noticeable on account of the absence of peaks or hooks and a gradual rounding of the compression curve into the discharge line; also the reëxpansion curve into the suction-pressure line. When the valves of a compressor are in this condition, it is difficult to decide what the position of the compression curve will be relative to the adiabatic and isothermal curves, as other conditions may affect the compression curve. Fig. 18 indicates that the suction valve is in a worse condition than the discharge valve.

The two diagrams, Figs. 19 and 19A are from each end of a horizontal double-acting compressor having a leaky discharge valve on the crank end and a leaky suction valve, also a binding discharge valve on the head end. It will be noticed that the compression curve, Fig. 19, lies above the adiabatic curve considerably. This is caused by high-pressure gas leaking back into the cylinder, either through the valve seat or the cage seat. Referring to the head-end diagram, Fig. 19A, the suction valve is not tight enough to resist the high-pressure gas toward the later part of the stroke, and some of the compressed gas leaks back into the suction pipe. The discharge valve also sticks or leaks and allows some of the discharged compressed gas to leak back into the compressor, causing a large reëxpansion loss before the suction gas enters. The compressor from which Figs. 19 and 19A were taken was much too large for the work it was doing, being of 50-ton ice-making capacity and working on a 25-ton freezing tank and doing no storage service. The effects of the leakage were therefore not noticed and were only brought to light when the indicator was applied. After the valves and cages

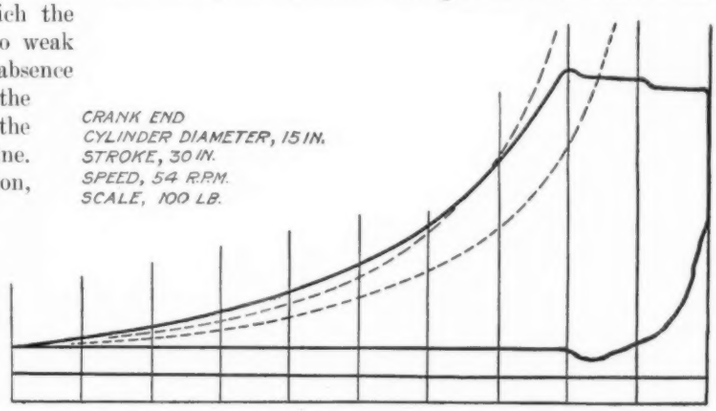


FIG. 19. DOUBLE-ACTING MACHINE, LEAKY SUCTION AND DISCHARGE VALVES

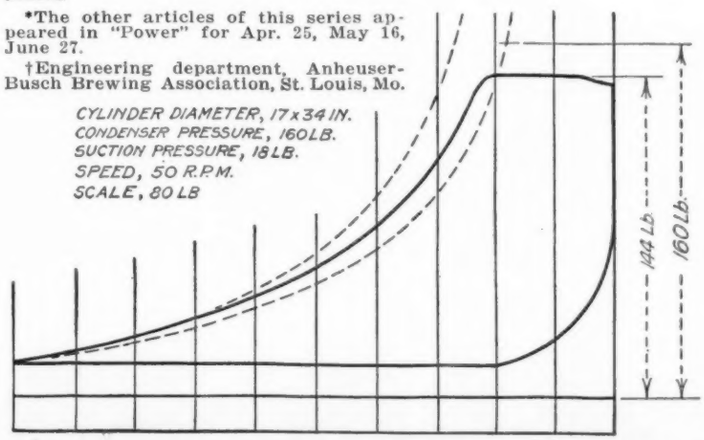


FIG. 18. VALVES LOOSE AND VALVE SPRINGS TOO WEAK

*The other articles of this series appeared in "Power" for Apr. 25, May 16, June 27.

†Engineering department, Anheuser-Busch Brewing Association, St. Louis, Mo.

were ground in tight, the compressor did the same work on 12 revolutions less speed, thereby saving much steam and coal.

Figs. 20 and 20-A illustrate another instance where it was not thought necessary to indicate the compressors. There are several machines at the plant where these diagrams were taken, and as long as the work was done it made no difference how many machines were run to do it or at what speed they operated. The machine from which these diagrams were taken might as well have been shut down as far as the amount of work it was doing was concerned. The head-end diagram, Fig. 20, shows leakage of high-pressure gas back into the cylinder after having been discharged into the discharge pipe, caused by either a leaky discharge valve or discharge-valve gasket, or cylinder-head gasket between the cylinder and discharge port. This leakage of the discharge valve also causes the large reëxpansion loss shown. The crank-end diagram, Fig. 20-A, indicates a leaky piston, as shown by the rapid falling off of the compression curve at the upper part of that line and also by the abrupt hook in the reëxpansion curve. The losses due to reëxpansion on these curves are from 30 to 35 per cent. The suction-gage pressure was 20 lb. at the time the diagrams were taken, but the suction pressure in the cylinder, as scaled on the cards, is from 9 to 10 lb. This drop of 10 lb. means considerable loss of capacity and is due to the suction pipe, suction valve and port area being too small. This plant had a good engineer, who indicated the steam engines regularly, but he never thought it was necessary to indicate the compressors. There are many engineers of the same opinion. The facts disclosed by Figs. 20 and 20-A admit of no argument as to the value of indicating the ammonia compressor. It sometimes happens that some foreign substance finds its way into the valve mechanism and can cause trouble. Such an occurrence is shown in Fig. 21. An examination revealed a piece of lead gasket in the spring, which retarded the opening and closing of the valve. Notice the reëxpansion curve; notice also that the line of suction pressure gradually drops to nearly the atmospheric line. Fig. 22 is

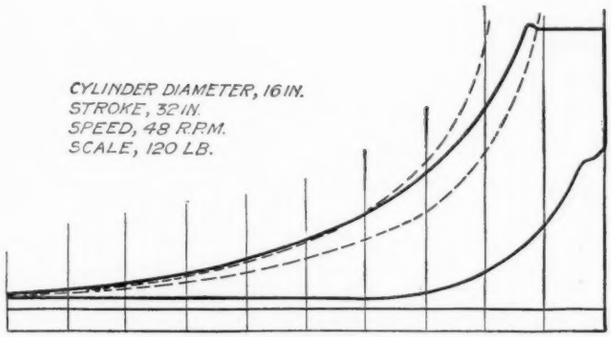


FIG. 20-A. INDICATION OF A BADLY LEAKING PISTON

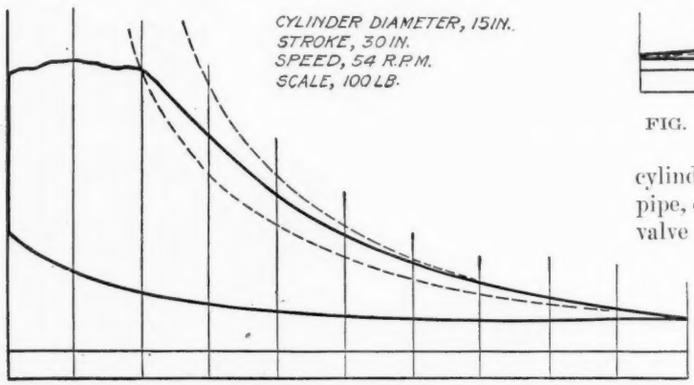


FIG. 19-A. COMPRESSED GAS LEAKS BACK INTO SUCTION PIPE

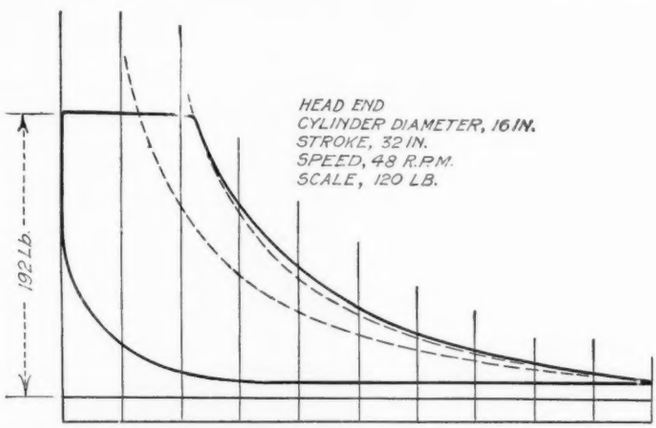


FIG. 20. DISCHARGED GAS LEAKS BACK INTO THE CYLINDER

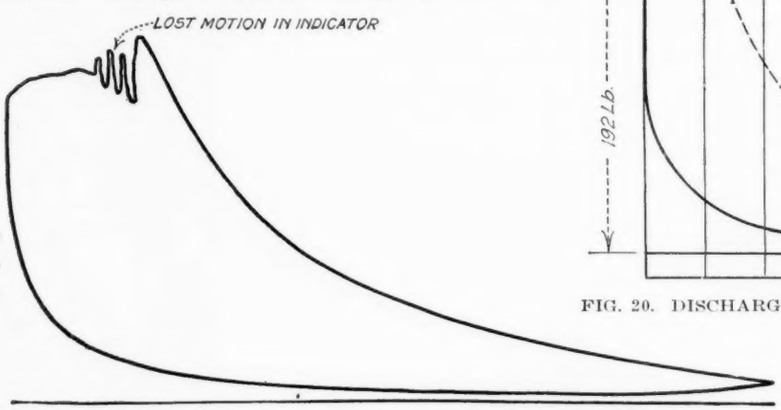


FIG. 21. FOREIGN SUBSTANCE IN THE VALVE MECHANISM

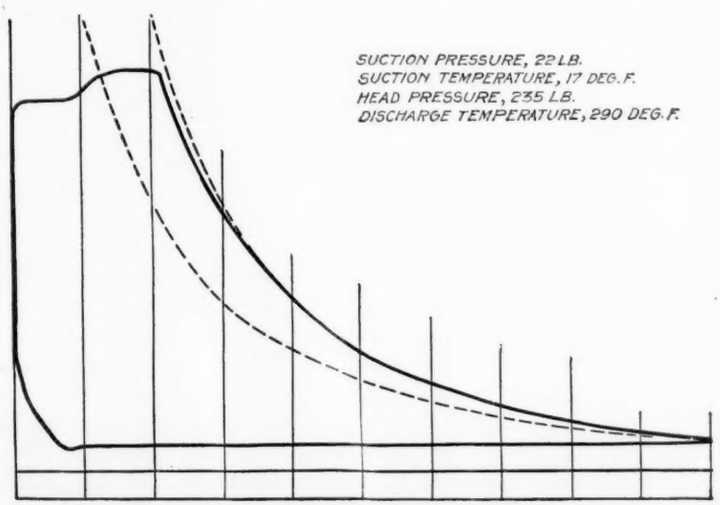


FIG. 22-A. SHOWS FIG. 22 AFTER ADJUSTING THE EXPANSION VALVE

from a horizontal double-acting compressor that was handling an excessive amount of liquid ammonia at the time the diagram was taken. Observe how the

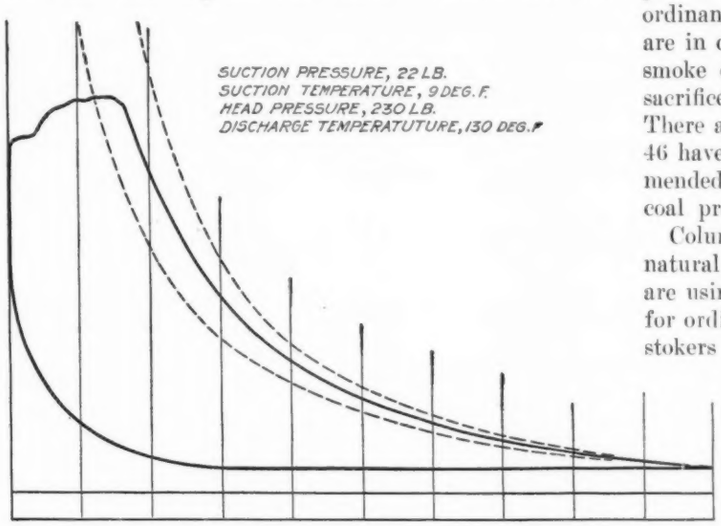


FIG. 22. MACHINE WAS PUMPING CONSIDERABLE LIQUID

compression line falls away from the adiabatic curve toward the isothermal; notice also the large reëxpansion loss. The discharge pipe of the compressor was cold, the temperature being 130 deg. F. When ammonia compressors are operated with cold discharge pipes, it is positive evidence that the machines are handling too much liquid, which causes great losses. After adjusting the expansion valves to reduce the feed, and after the excessive liquid was disposed of, which required an interval of 40 min., Fig. 22-A was taken. The suction pressure was the same in both cases.

The gas was now entering the compressor with 8 deg. superheat, and the discharge gas temperature was 290 deg. F.

A comparison and study of these two diagrams together with the conditions should make it evident to any engineer operating an ammonia compressor, as to which condition gives the most efficient results.

Smoke Situation in Columbus

W. D. Ranney, chief of the Columbus, Ohio, Smoke Department, reports that Columbus is waging a smoke-elimination campaign, being supported by the Chamber of Commerce and all good business men, and although of only about one year's duration much good has been done.

About a year ago Columbus was a fair competitor of many of the larger cities from a dense-smoke producing standpoint, but now the local weather bureau does not record so many days of dense smoke, or so few clear days each month for every day that dense smoke can be seen. While there is still much room for improvement in many sections, especially with railroad locomotives, nearly all the larger plants and many of the smaller ones have been improved.

Twenty-nine tests have been run by the Smoke Department, with the necessary instruments to ascertain furnace efficiency, without cost to the owners, most of whom have since installed some form of stoker or improved furnace which stops smoke and gives them a much higher efficiency.

Sixty-two permits have been issued for improved equipment, and out of a total of 626 plants 203, or over 32 per cent., are within the requirements of the city smoke ordinance. Steam-air jets are not recommended, but 22 are in operation in the city, and these assist in reducing smoke density when used faithfully, but always at the sacrifice of economy and efficiency, says the inspector. There are 36 plants now using mechanical stokers, while 46 have installed some form of improved furnace recommended by the department, and all may now burn Ohio coal profitably without objectionable smoke.

Columbus has 101 industrial establishments burning natural gas, while over ten thousand domestic furnaces are using the same fuel. A good grade of fuel is urged for ordinary furnaces already established, but mechanical stokers are recommended for all power plants of 100 hp. or more and improved furnaces for all return-tubular boilers improperly set.

Many of the stoker plants show a distinct saving over hand firing of from 7 to 24 per cent. of the annual fuel bill. One plant made a clear saving of $2,000 in one year, or 34.2 per cent. over hand firing. The Columbus Filtration plant will save $1,500 per year over hand firing.

No court action has yet been taken against offenders, and when they go to court will depend entirely upon their own conduct.

Laboratory Muffle Furnace

By R. E. Clizbe*

The muffle furnace, together with the regulating transformer and switchboard shown in the drawings, was made for the purpose of burning small coal samples to determine the ash content. It can be used for all classes of work that do not require a temperature higher than 2,400 deg. F. With the outfit shown, the heat can be brought up quickly and maintained at any desired point within the limits of the furnace. It is not expensive to build and is more convenient than a gas furnace. The cost for power is small, as little of the heat is wasted.

The furnace can be used without the transformer, but the design would have to be changed to operate direct on 110 volts, as the winding shown would get too hot and eventually burn out at this voltage. Also, without the transformer the regulation would be poor, and it could be used at only one heat. The transformer is made with a secondary having taps for each 4 volts from 4 to 110, so that the furnace can be started at a high rate and the heat brought up quickly, after which the rate can be cut down to just enough to maintain the heat desired.

The winding will stand up under a steady heat of 2,400 deg. F., but seems to deteriorate at higher temperatures and will melt at 2,700 deg. However, for the purpose that such a furnace usually serves—burning for ash and so on—a heat of 1,800 deg. is ample. Under these conditions it should last for years.

The shell is of alundum which can be purchased in any form desired and from dealers handling laboratory supplies. It is made especially for this class of work, and in this case it is in the form of a tube flattened on one side. One end is closed, and the other is left open. The

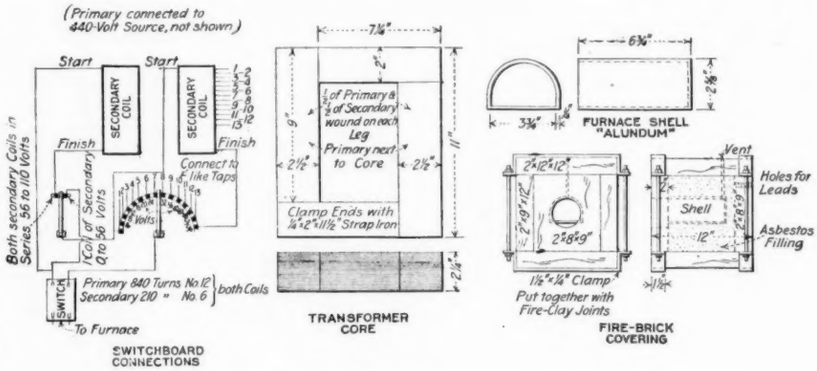
*Superintendent of motive power, Clinton Sugar Refining Co., Clinton, Iowa.

length is 6¾ in. and the diameter is 3¾ in. The winding is made up of 35 ft. of No. 13 Nicrome second resistance wire (any resistance wire having the same resistance per foot that will stand this temperature will do), which is wound directly on the shell and then covered to the depth of ¼ in. with alundum cement. This is alundum in powdered form. It is mixed with water and put on like putty, after which the heat hardens it and leaves the winding covered so there is no chance for it to corrode from the action of gases which may be generated in use.

The shell is placed in a firebrick covering, as illustrated, and the space around filled with asbestos. Ordinary pipe covering will do. The outer covering can be made of any firebrick at hand. This one was made of old baffle tile. If the shell is packed in well, the outer covering will be cool enough so that the hand can be left on it while the furnace is in operation. The firebrick forming the outer covering are fastened together with clamps made of 1½x¼-in. strap iron bent into shape. There is a small vent left at the rear of the shell to carry away the products of combustion. By putting a pipe on this it will act like a smoke-stack. This pipe can be led out through the wall and so do away with all gas from burning. To cover the hole in the front firebrick leading into the furnace, set a firebrick on edge in front of it or make a plug of firebrick to fit it. This will keep the heat in while in use and save power. It is well to bring the ends of the resistance wire out through the firebrick and make the connections outside, as sometimes there is trouble at the connectors, due to the heat. This arrangement saves taking the furnace down.

The transformer is wound for 440-volt primary and for from 4- to 110-volt secondary. It is of the core type, made up of sheets cut as shown in the drawing. The core weighs about 35 lb. The winding is made in two coils, which are put one on each leg. After the coils are on and the lamination built up, it is secured in place with 2x½-in. clamps on each end.

The primary is wound next to the core and is made up of 840 turns of No. 12 double cotton-covered magnet wire, 420 turns on each coil. The secondary is 210 turns of No. 6 double cotton-covered magnet wire, or 105 turns on each coil. One of the secondary coils has taps left out every eight turns and connected as shown in the drawing, to get the different voltages. The total length of the primary winding is 497 ft. and of the secondary 192 ft. This transformer is rated at 2.2 kw. The efficiency is high for a small size.



DETAILS OF FURNACE TRANSFORMER AND SWITCHBOARD

The drawing of the switchboard explains itself. It is not intended to give details of construction, but merely the idea. In this case it is only necessary to make the contacts heavy enough to carry the current, which is about 20 amp. at the higher voltages.

Care of Leather Belts

By J. O. Benefiel

Having had many years' experience in the care and operation of belts, I thought that perhaps our methods might be of interest to *Power* readers and perhaps bring out discussion that would show where we could improve our method. It is very easy to drive a belt fastener into a piece of leather, but it is just as well before doing so to think how much it will weaken the belt at that point and how much service you will lose from your machine through the failure of the fastenings.

The most satisfactory method of joining belting is by making a cemented lap joint. This is a simple operation when once learned, and there is no good reason why most of the belts in a mill or factory should not be put together that way.

As an example, a 10-in. double leather belt, Fig. 1, should have a lap 12 in. long. First measure back 12 in. and draw a line across square with the edge of the belt, then separate the plies with the opener back 9 in. and cut off one ply *B*, and with a plane or heel-shave bevel the top ply back to the 12-in. line *C*, then turn the belt over and bevel the end 3 in. back on the opposite side, as at *D*. Bevel the other end of the belt to match, which of course would be just opposite; then with the belt scraper go over the lap, making it all even and smooth so both plies will come in contact at all points. This completes the preparatory work, and the joint is ready to cement. Be sure the glue is not too thick and very hot but not boiling; if the room is cold, it may be necessary to heat the belt before cementing it together—using hot bricks or boards. Apply the cement to both surfaces with a brush, rubbing it in thoroughly but not too liberally, for the less the amount of glue left between the surfaces the stronger the joint. The surfaces are to be entirely coated with the glue or cement. Rub and hammer the surfaces of the lap together thoroughly to drive out all the air, proceeding a little at a time until the entire surface is cemented and hammered so that the surfaces are in close contact. The rubbing is done with what is called a slicker, and the hammer is usually a shoemaker's pegging hammer. Pay particular attention to the edges and ends of the lap. If the belt is large, do not attempt to cement too much surface at one time and do not allow the cement to become chilled. After two hours in a reasonably dry, warm room, it will be

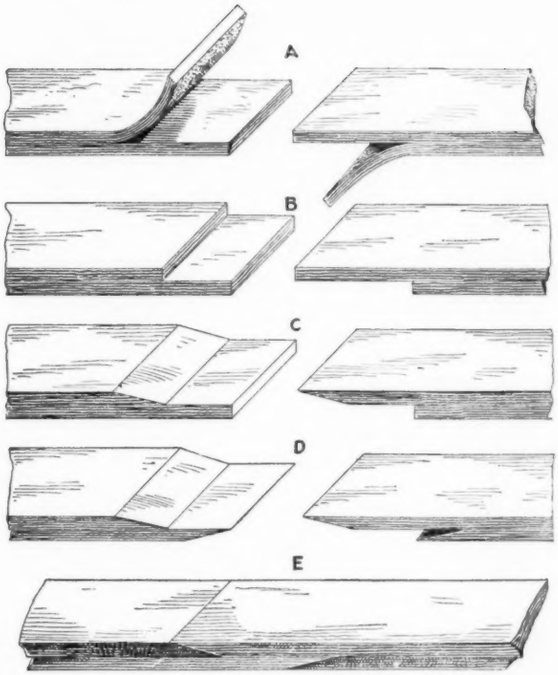


FIG. 1. PROCEDURE IN PREPARING A TWO-PLY SPLICE

safe to take off the clamps, if they have been used, and put the belt to work.

Sometimes the belt has to be spliced on the pulleys—especially if it is of considerable size. It should be put on so that the inner point of the laps already made point in the opposite direction to that in which the belt runs and the new or joining lap comes the same when the ends are in position for cementing together. Place the clamps on the belt, one of them about 6 in. back of the end of the lap and the other as far back as the length of the rods will permit, with the belt exactly in the center of the clamps and square with the edge. Draw the belt up a little tighter than the running tension to allow for the slack between the clamps. A board just wide enough to go between the rods and long enough to extend under the entire lap, fastened to the rods, makes a handy table on which to shave the laps down and fit them together. After the lap is fitted and before cementing together, see that the edges of the belt

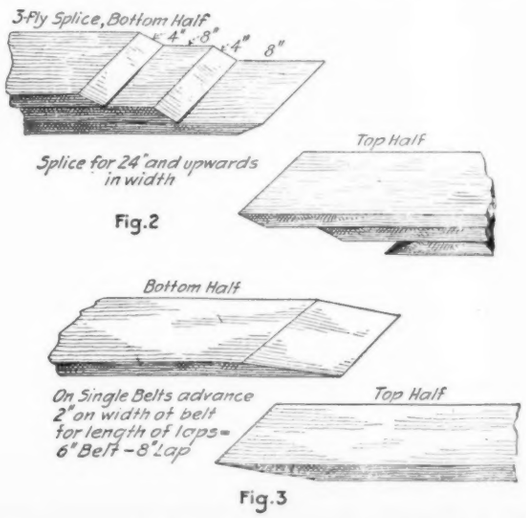


FIG. 2. THREE-PLY AND FIG. 3, A SINGLE-PLY SPLICE

are straight. This is done by drawing upon one of the rods to bring it in line, after which it is sometimes necessary to refit the lap. A little clamp slippage will throw the edges out of line and the laps out of square, and it is found necessary in some cases to square the clamps with a rope attached to opposite corners of the clamps and twisting the rope with a short stick until the laps come square with each other. The cementing is then proceeded with as described.

For 3-ply belt the cementing and clamping is the same as for 2-ply, and the laps may be made as shown in Fig. 2. A single-ply splice is made with a straight bevel all the way across the surface of the lap, as shown in Fig. 3. Pulley diameters for thick belts should be proportioned to the thickness of the belt. A heavy 3-ply belt will not last well on a pulley of less than 8 ft. diameter on account of internal stress set up in the belt.

The tension is of great importance, both to the life of the belt and the consumption of power. If too tight, there is a waste of power in friction and a loss of life

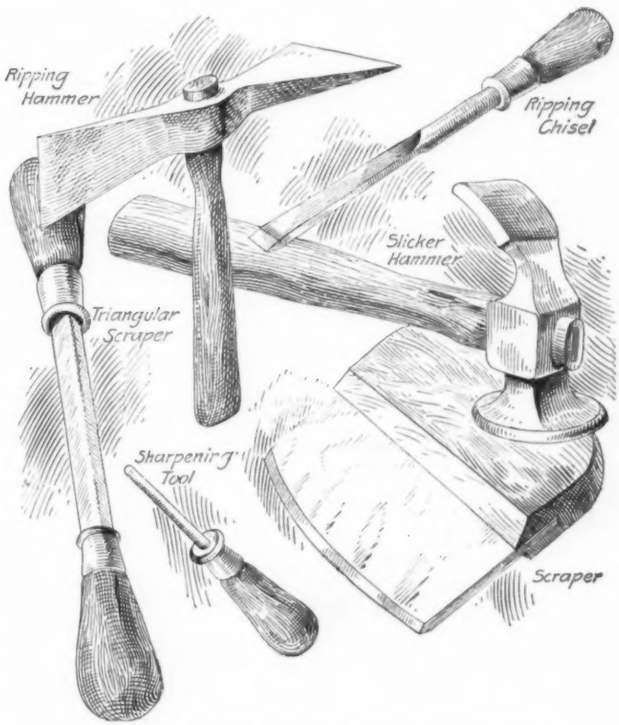


FIG. 4. PART OF THE BELT SPLICER'S OUTFIT

in the belt by excessive straining. On the other hand, if too loose, the belt may jump off the pulleys, especially with a variable load, and continual slipping causes a loss of efficiency in the machine driven—strive for the happy medium. A loose belt that does not slip or run off the pulley is most economical in both the foregoing points.

It must be borne in mind in installing belting and taking it up that it is considerably affected by atmospheric conditions—lengthening or shortening according to the humidity of the air. Instances are known where shafting has been pulled down and babbitt melted out in damp weather.

Belting is ruined by pulleys and shafting being out of alignment. Under such conditions belts are kept on the pulleys by guides or run against hangers or parts of the machine, and a lap is soon opened, catching in something, and the belt is torn or stretched unevenly and

will not run straight, gives trouble by coming off and is eventually ruined.

The following are good general rules: Keep the shafting and pulleys in line. Run the belts as loosely as they will work efficiently. Avoid sticky belt dressings; put a good dressing into a too-dry belt and take the grease out of belting that is too oily. Keep all driving surfaces clean. Run belts at as near a uniform tension as possible. When taking up a heavy belt, it is well to examine hanger and pedestal bolts; if the bolts are slack and the box moves, a kinked shaft is the result. Too much grease is injurious to leather and mineral oil in particular rots it, so where it is in danger of becoming soaked with oil, means should be used to keep the oil away. When belts become oily, they should have the oil neutralized or extracted with naphtha, gasoline or carbon tetrachloride, or by packing the belt in dry sawdust or shavings. If it is not possible to remove the belt, wiping it with a dry cloth or some absorbent material will help. Washing the face of the belt with gasoline gives good results, taking care to wipe it thoroughly and being sure there is no fire around.

FIG. 5. COMRADES

An oil-saturated belt can be cemented successfully by thoroughly washing and soaking the lap in gasoline, then allowing it to dry well before making the joint.

When belting appears dry, it should be cleaned thoroughly of all dirt or gum sticking to it, by rubbing it with a cloth dampened with kerosene. In bad cases use a wooden or metal scraper to give a clean surface, then apply some good belt dressing. This should be allowed to soak in before more is applied, repeating at intervals to keep it in good condition.

A good formula for belt cement is as follows: For a common-sized pot of belt cement use three-fourths good grade of common glue to one-fourth gelatin soaked in water about five hours. Then mix in two tablespoonfuls of tannic acid, one tablespoonful of boracic acid and one teaspoonful of oxide of zinc before putting on to cook. As soon as it is all melted and is about the consistency of the white of an egg, it is ready to use. This cement will not deteriorate with age.

The length of the lap for a good joint should be about 2 in. greater than the width of the belt.

The following outfit of tools is needed for belt splicing: Clamps and rods, belt scraper, slicker, belt shave, small plane, turning steel for turning the edge on the scrapers, awl, ripping hammer, pegging hammer, glue pot and kettle, one 3½-in. first-quality brush, one square and one good knife. One each of these tools is required, except there should be two or three scrapers, and for a variety of belts, several sets of clamps will be needed.

To find the length of belt required for a given drive when the pulley diameters and distance between centers are known and the pulleys are the same or nearly the same diameter, add ½ the circumference of each pulley to twice the distance between shaft centers, the result the belt length less that required to make the splice.

When one pulley is considerably larger than the other, square the distance between the centers of the shafts, add to this the square of the difference between the radii of the two pulleys, from this total extract the square root and multiply by 2, thus acquiring total A. Add the diameters of the two pulleys together and multiply this sum by 3.1416. Add to one-half of this product the total A and you will have the required length less the amount required for lap.

The rules are very good when getting the belt lengths on a job that is not yet set up is necessary; but where the pulleys are up, a steel tape or if necessary two such tapes wired together is entirely satisfactory.

Boiler Header Handhole Cap

The illustration shows a handhole cap for use in the tube headers of water-tube boilers having headers of the Heine type. It is of pressed steel, the convex side being against the pressure. The cylindrical end tapers and fits in the header like a cork in a bottle. An expander is used to tighten the cap after it is in its place. It does away with gaskets and bolts in making tight the tube holes and is inserted through the oval holes at the top and bottom of the header.

This expander is of special design to meet the requirements of the cap. It is self-feeding, with a retarder

KEY BOILER HEADER PLUG

on the feed to prevent tightening of the rolls beyond the pressure desired to be exerted. This feature of the expander is under control of the operator at will and without this feature experience has shown it to be impossible to expand the caps satisfactorily. The inventor advises that a number of the caps are in service in boilers carrying 225 lb. pressure.

The cap and expander were invented by and are sold by Fred Key, 641 Pierce Building, St. Louis, Mo.

Cement for Steam Pipes—Cement of specially valuable properties for steam pipes and for filling up small leaks such as blow-holes in a casting, without the necessity of removing the injured pieces, is composed of 5 parts by weight of paris white, 5 of yellow ocher, 10 of litharge, 5 of red lead, and 4 of black oxide manganese, these various materials being mixed with great thoroughness, a small quantity of asbestos and boiled oil being afterward added. The composition, as thus prepared, will set hard in from two to five hours and possesses the advantage of not being subject to expansion and contraction to such an extent as to cause leakage afterward, and its efficiency in places difficult of access is of special importance.

Smoke Abatement at a Dayton Power Plant

By Charles C. Moore*

SYNOPSIS—Employment of large double-faced steam gage, illuminated by a red, green or white light, as determined by the damper regulator, controlled by the steam pressure, resulted in reducing objectionable smoke from 18 to less than 1½ per cent. in 24 hr., with less fluctuation in steam pressure and less supervision.

Some time ago the writer was asked to operate the boiler room so that the smoke emitted from the stack would comply with or be less than the requirements of the various smoke ordinances. To determine what could be done to reduce the smoke to a minimum necessitated personal supervision of the firing for two days. During this time much walking was necessary in connection with keeping the steam constant. The boiler room, which contains 16 boilers mechanically stoked, all facing south and in line, is 212 ft. long. While each boiler is equipped with an individual gage 12 in. diameter, it became necessary to refer constantly to the recording steam gage, located on the board shown in the illustration, to see what results individual efforts made on the pressure in the main steam header.

This frequent walking back and forth, timed by a stop watch, consumed 83 per cent. of the time; the balance was used in stoking and cleaning the fires. The effort put forth demonstrated that the objectionable smoke that had been emitted under the lax system of firing, amounting to about 18 per cent. in 24 hr., had been reduced to less than 2½ per cent. under the more scientific control.

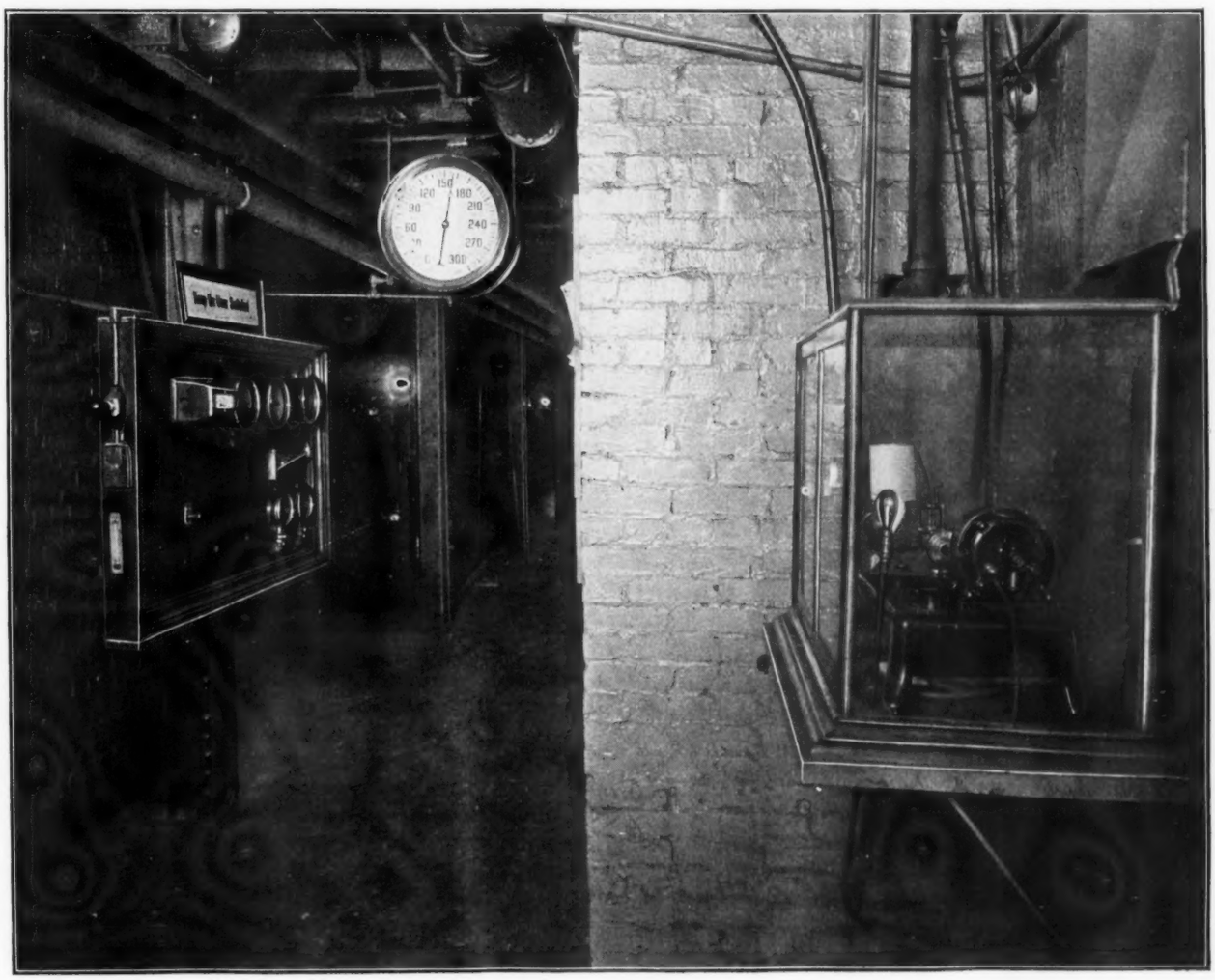


FIG. 1. SHOWING THE DOUBLE-FACED ILLUMINATED STEAM GAGE, CONTROL BOARD AND SMOKE RECORDER

While in this study it occurred to the writer that if a large amount of this 83 per cent. of the time could be applied to study and firing instead of walking to and from the central recording gage, still better results could be obtained. With this idea in view a transparent, double-

*Chief engineer of power station of the National Cash Register Co., Dayton, Ohio.

faced, 20-in. illuminated steam gage was purchased, installed and hung centrally in front of the furnaces in such a way that it could be observed from either end of the plant. Within the gage were placed three lights—red, green and white—which in turn were connected to a sliding switch operated from the main damper regulator, the latter being actuated by the steam pressure in the main header. As the steam gage and damper were both controlled from the same source, the observations and actuations were simultaneous and nonconfusing.

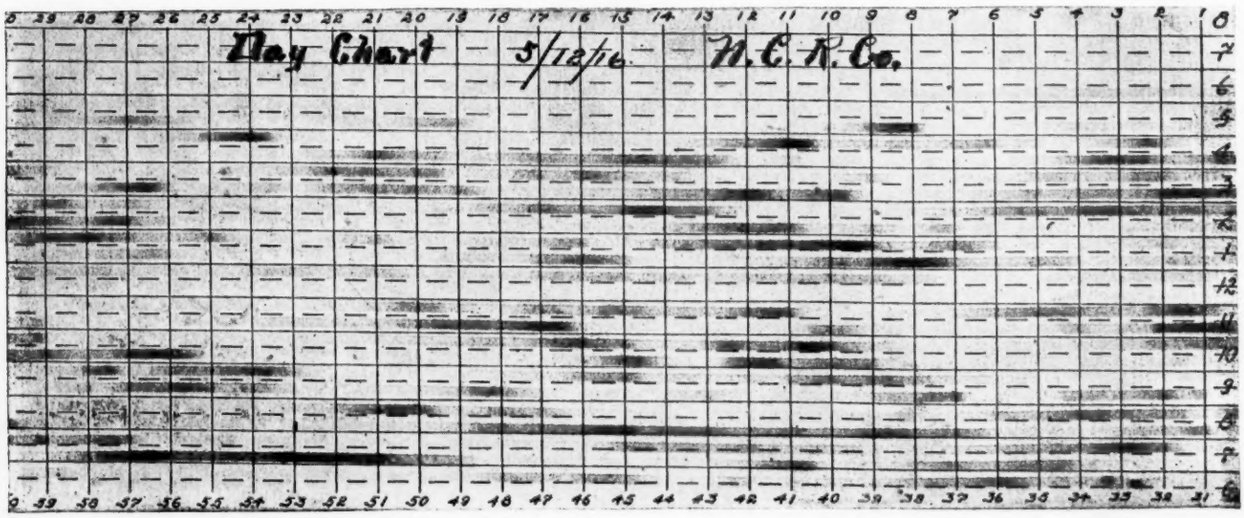


FIG. 2. SMOKE CHART FOR MAY 12, 1916

The way this served to produce and maintain smokeless efficiency was as follows: When the steam was at the low point of the operation, the gage indicated it. The damper regulator was down, the damper in the stack open and, the switch being in the proper position, a red light illuminated the gage on both sides. This being observed by the two firemen in control indicated to them that this was the time to stoke the fires, level them off or do the various other duties necessary, as at this time the greatest amount of air was entering the furnaces and a minimum amount of smoke would be caused by any of the usual disturbances. As a result of this stoking, the steam naturally tended to rise and the damper to close. This was indicated on the gage, and as the damper regulator controlled the damper in proportion to the rise of the steam pressure, it also carried the switch with it and at one-third of the travel the light illuminating the gage changed from red to green. This notified the firemen that it was time to let up on the stoking, as further effort would only tend to aggravate the smoke nuisance due to the reduction of air inflow. As the fires were stoked sufficiently to carry the steam pressure about 6 lb. from the red-light position and as the green light was set to come on at the third and off at the fifth pound, the continued rise changed the damper to a position where the minimum amount of air entered the fires, and this in turn was represented by the switching from the green to a white light to illuminate the gage and indicate high steam pressure. As the firemen understand it, this is no time to stoke the fires or disturb the fuel beds, for it had been found that the least disturbance in a single furnace at this time would turn the smoke dense black. The firemen utilize the white-light period in making inspections of the fires and resting. When the steam turns, the lights are reversed from white to green and then to red, when the operation just described is repeated.

The result has been a reduction of from about 18 per cent. to less than 1½ per cent. of objectionable smoke in 24 hr., and unless something beyond the firemen's control happens, the stack is always within the smoke-ordinance requirements. Seventy per cent. of the walking has been eliminated, the operators are more contented, there is less fluctuation in steam pressure, the fires are more efficient and a considerable reduction in supervision has been effected. The accompanying smoke chart represents an average day's run.

Rod- and Pump-Packing Pointers

By A. Harper

Engineers who are bothered with packing troubles, especially from rods working out of alignment or worn rods, should try a good springy or sectional packing. If the rod does not fit the bottom of the stuffing-box, a ring of high-pressure asbestos should be put in first and the packing cut with the ends beveled and long enough to make as perfect a joint as possible to prevent the water from washing away the rubber from the ends of the rings, which is generally the chief cause of failure.

If the packing should leak when starting up a cold engine, do not screw it up tight until the engine is thoroughly warmed or a scored rod will be the result, while if properly adjusted, the packing will last twice as long.

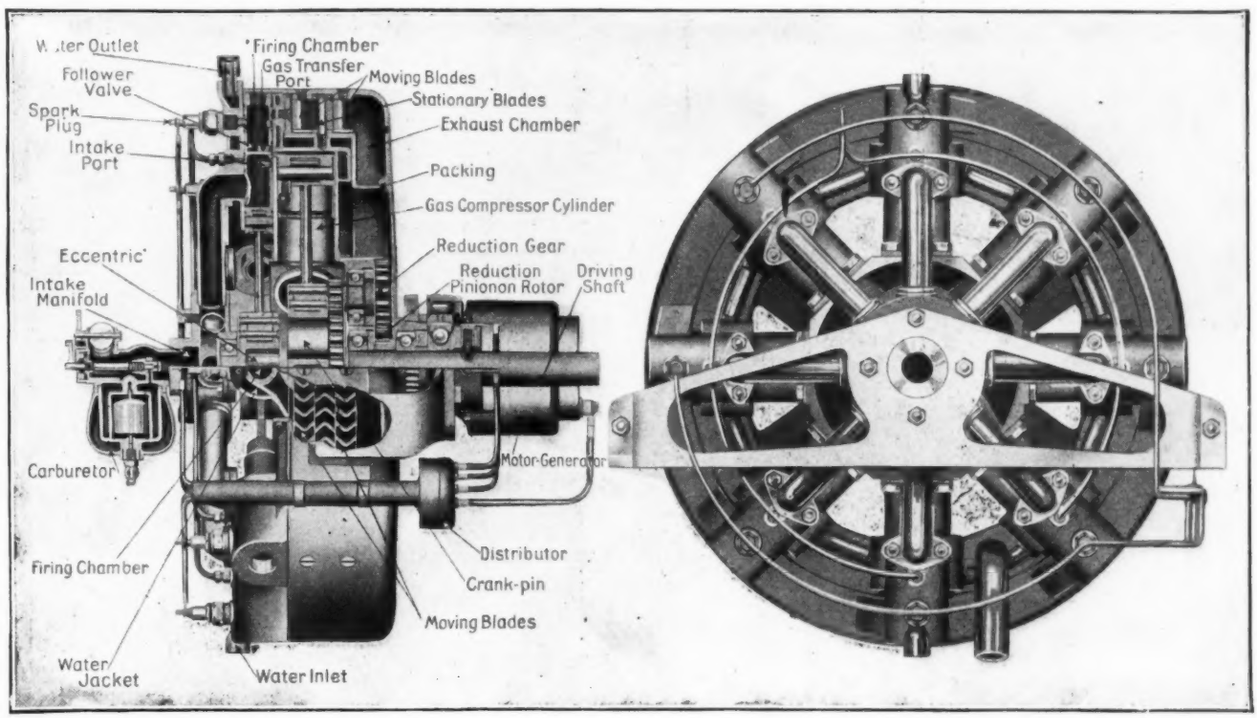
When packing inside-packed pumps, especially when forced to use unsuitable or inferior packing, cut the rings about ⅛ of an inch long and press them outward against the pump barrel, thus giving less chance for the water to leak past the packing and, consequently, longer life. Care should be taken always to clamp the packing firmly with the follower plate, as in a vise, to hold it in place so it can't get away.

To Frost Brasswork and give it an ornamental finish, boil the article in caustic potash, rinse in water and dip in nitric acid until all oxide is removed; then wash quickly, dry in boxwood sawdust and lacquer while warm.

Detroit Gas Turbine

A gas turbine of novel design has been produced recently by the Detroit Gas Turbine Corporation. Briefly, the principle of operation consists in compressing a charge of the mixture, firing it at constant volume in an explosion chamber, which results in very high pressure, and allowing the products of combustion to impinge on a series of moving and stationary blades.

Referring to the sectional view and taking up the operation in detail, on the down stroke of the compressor piston the mixture is drawn in through the intake manifold, intake port of the follower valve and cylinder port to the compressor cylinder. The follower valve is eccentric-



SECTIONAL AND END VIEWS OF DETROIT GAS TURBINE

driven, and by the time the compressor piston has reached the bottom of its stroke the cylinder port is covered. On the up stroke the mixture is compressed to about 90 lb., at which time the follower valve begins to uncover the cylinder port and the mixture passes through the transfer port into the firing chamber. Here it is fired by a spark, by which time the upward movement of the follower valve has caused it to again cover the cylinder port and the impulse port comes opposite the passage to the blades. The products of combustion at high pressure then impinge first upon a row of moving blades, then upon a row of stationary blades and finally upon a second row of moving blades, from which they pass into the exhaust chamber at a pressure said to be about 3 lb. The moving blades are carried on the outer casing, which revolves about the driving shaft on a set of ball bearings. It carries a pinion that transmits driving power to the shaft through a 3 to 1 reduction gear. The shaft speed is 3,000 r.p.m. and that of the rotor 9,000 r.p.m., which is equivalent to 24,000 explosions per minute. The motor is not reversible.

The effective rotor diameter of a 200-hp. turbine is said to be 21 in. and the weight 335 lb.

The Effect of Soot on Heat Transmission

In a paper read before the Ohio Society some years ago by J. E. Bell, the following experiments were reported. A series of tests were made upon boilers in the anthracite district to determine what effect dirt on the outside of the tubes and scale on the inside had on the evaporation.

The boiler chosen had not been cleaned for several months, either externally or internally. Internally it was in fairly good condition, only a slight coating of scale appearing on the tubes. The outside of the tubes, however, was coated all over with a heavy ash deposit, and every portion of the tube offering a lodgment for dust contained all that it could hold. With the boiler in this condition the evaporation obtained per pound of dry buckwheat coal was 8.04 lb. from and at 212 deg. F. A few days afterward the boiler was thoroughly cleaned and put in good condition and another test run, in which the evaporation obtained was 10.3 lb. from and at 212 deg. F. per pound of dry coal. This indicated a gain in economy of 27 per cent. resulting from cleaning the boiler. No doubt this was an extreme case, and it seems almost an insult to an engineer to advise him to see that his boiler is clean before testing, but in spite of assertions to the contrary, the chances are ten to one that the boiler will not be clean.

While the foregoing is good advice in case of a boiler test, it is likewise good for everyday practice for every day should be test day and a daily effort to obtain the highest possible evaporation per pound of coal has a great deal more to do with the amount of the annual coal bill than a single test conducted under the best of conditions. If more boiler trials were conducted under everyday operating conditions, a lot would be learned and more practical results obtained than by tests under abnormal conditions.

There is one thing that is particularly discouraging to an engineer in trying to obtain the best of results from his plant, and that is to have first-rate work done during the test day and the next day have it done in a slipshod manner so that it is impossible to get anything like test results.

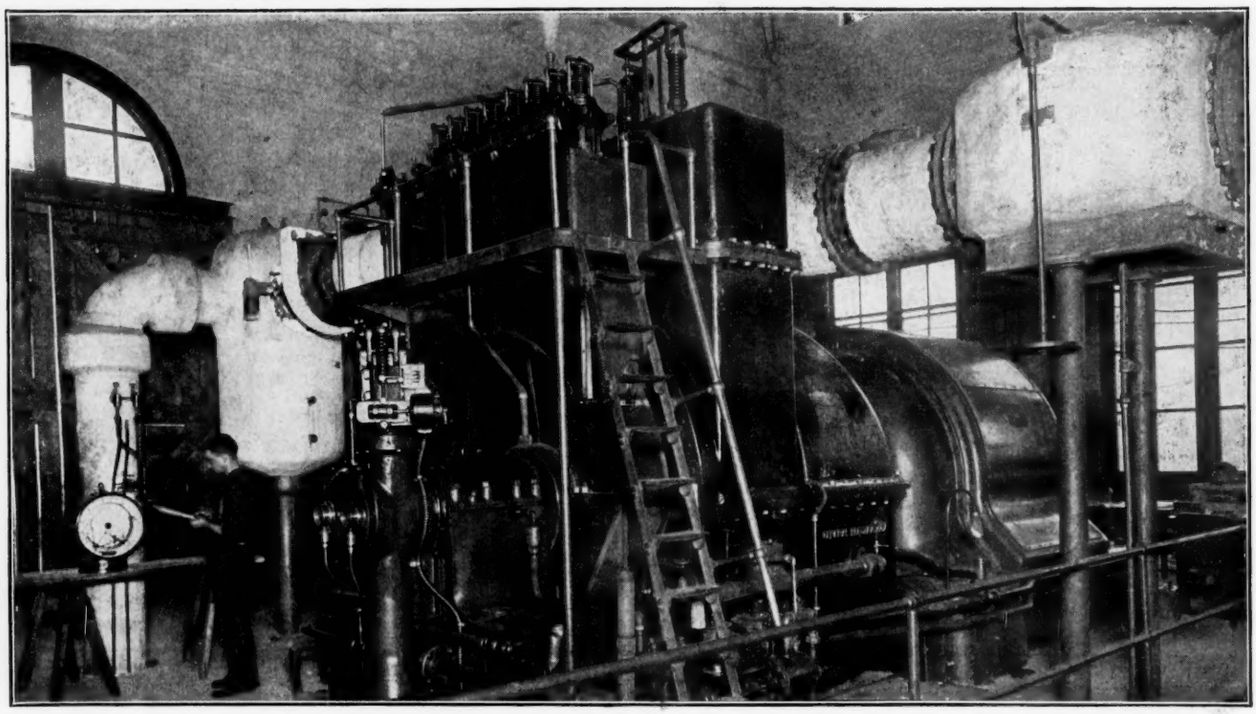
There is no doubt that the engines and other steam-using apparatus are blamed frequently for being wasteful of steam when the calculation is based on the test output of the boiler, while in fact the boilers are not producing the steam credited them, as shown by the tests.

Largest Bleeder Turbine

By Eduard Mayl

The 7,500-kw. bleeder-type steam turbine erected[1] in the plant of the Dayton Power and Light Co., at Dayton, Ohio, is the largest of its type in the world.

The bleeder connection attached to the district steam-heating system of the lighting company is designed to deliver, after the first stage, 40 tons of steam per hour.



LARGEST BLEEDER TURBINE, CAPACITY 7,500 KW., INSTALLED AT THE PLANT OF THE DAYTON POWER AND LIGHT CO.

The remainder of the steam passes through the other four stages of the turbine to the condenser. The turbine as operated during the winter months will be furnishing 40 tons of steam per hour after the first stage, to the heating system, and 45 tons more will go through the other four stages of the machine to the condenser. The turbine under these conditions develops approximately 10,000 hp.

Tests were made under the supervision of E. D. Williams[2], J. Hedefine[3] and E. D. Doyle[4]. Twenty men, each working fifty hours per week for a period of seven months, were employed in erecting this turbine.

For winter operation it is estimated that the turbine will require 264 tons of coal per day and the current generated will be sufficient to illuminate 300,000 25-watt Mazda lamps. Two more units of this large bleeder type are being constructed for the Dayton company, which plans to use them in its new plant at Miller's Ford.

[1]Erected by the General Electric Co.
[2]Turbine engineer of the General Electric Co.
[3]Erecting engineer of the Alberger Pump and Condenser Co.
[4]Assistant engineer of the Electrical Testing Laboratories of New York City.

Steam Flashing from Hot Water

The percentage of hot water under high pressure that will flash into steam on being released to the atmosphere may be calculated in the following manner: The difference in the total heat of the fluid at the higher pressure, as shown by the steam table, and that in the water at atmospheric pressure, represents the heat (B.t.u.) that will become available to convert the water into steam. The latent heat of evaporation at atmospheric pressure (970.4) represents the work to be done in converting one pound of the water into steam. Therefore the difference in the total heat contained in the water at one pressure and temperature and that contained in the water at atmospheric pressure and temperature divided by 970.4, will give the high-temperature water that will be converted into steam at the lower pressure and temperature. Example: At 150 lb. absolute, the total heat above 32 deg. F. in one pound of the water is 330, and at atmospheric pressure it is 180. Then $330 - 180 = 150$, the heat units used to convert the water into steam. The latent heat of evaporation at atmospheric pressure is 970.4, therefore $150 \div 970.4 = 0.165$, or 16.5 per cent. Thus it will be seen that about one-sixth of the total weight of water will be converted into steam if the pressure is reduced from 150 lb. to atmospheric. Other values may be worked out by taking any desired steam pressure and working to any other desired lower pressure and temperature by using the relative total and latent heat values.

This phenomenon is noticeable on blowing-down boilers under high pressure or watching the discharge from a steam trap in good working order, delivering the water from a steam pipe containing high pressure. It also constitutes the greater part of the destructive force let loose at the time of boiler explosions, and explains why the most destructive ones occur where boilers containing a large amount of water are concerned.

Superno Superheater

The "Superno" superheater, manufactured by the Superno Co., Inc., 52 Broadway, New York City, is made with heavier-gage tubes than usual, which are welded into headers. Referring to Figs. 1, 2 and 3, superheaters are shown constructed for attaching to Wickes horizontal water-tube boilers of standard design, and to Badenhausen boilers respectively. The superheaters used with the Wickes vertical and the Badenhausen boilers are of special design.

In construction the superheater, Fig. 2, is made with groups of tubes, the tubes of each group increasing in number and decreasing in diameter in the direction of the steam flow, the cross-section of all groups of tubes being practically equal. The headers are divided into sections by welded-in plugs so that the steam, after passing through the first bank of tubes connecting with the inlet nozzles, goes to the second section of the first header, then to the second section of the other header, to the third section of the first header and to the outlet connection for the main steam line.

The same idea is carried out in the design shown in Fig. 1, the tubes of which are curved to accommodate the boiler. This is also true of the superheater shown in Fig. 3. In this design four headers are employed with connections at one end of two headers, as shown. This type is being constructed for attaching to 2,500-hp. Badenhausen boilers.

Superno superheaters are built for boilers varying from 275 to 2,500 boiler horsepower at working pressures up to 225 lb. and to give from 150 to 372 deg. F. superheat.

Some Balancing Kinks

By Gordon Fox

It sometimes happens that a motor is found to be out of balance. Most frequently the trouble is in the pulley, since the armature is carefully balanced when built. Where there are no balancing ways at hand and it is somewhat difficult to remove the pulley, balancing by repeated trials is apt to be tedious if no system is followed, but it can be hastened by the following method:

A small piece of soft putty is placed on the inner rim of the pulley, and the motor is run for a time. Centrifugal force will cause the putty to flatten out in the rim and also to flow or creep slowly toward the light side. Sufficient vibration occurs to work the putty around the inner rim, and when vibration has about ceased, the putty has located itself and the motor may be stopped. The central point of the putty now represents the light spot. If the putty is pretty well concentrated, its weight is approximately correct for a concentrated metal weight. If it is spread out, a metal weight of lesser value may be substituted. If the pulley is being used temporarily, as for a test, it may not be necessary to replace the putty, as it will stay in place and maintain the balance.

Vertical motors are often called upon to carry weight upon their thrust bearings in addition to that of the armature. It is therefore customary to test them out with a heavy flywheel attached to the lower shaft extension of approximately the weight which service conditions will demand. It is somewhat difficult to balance such a wheel perfectly for high speeds, particularly if bushings are used, and severe vibration may be set up. Because of the

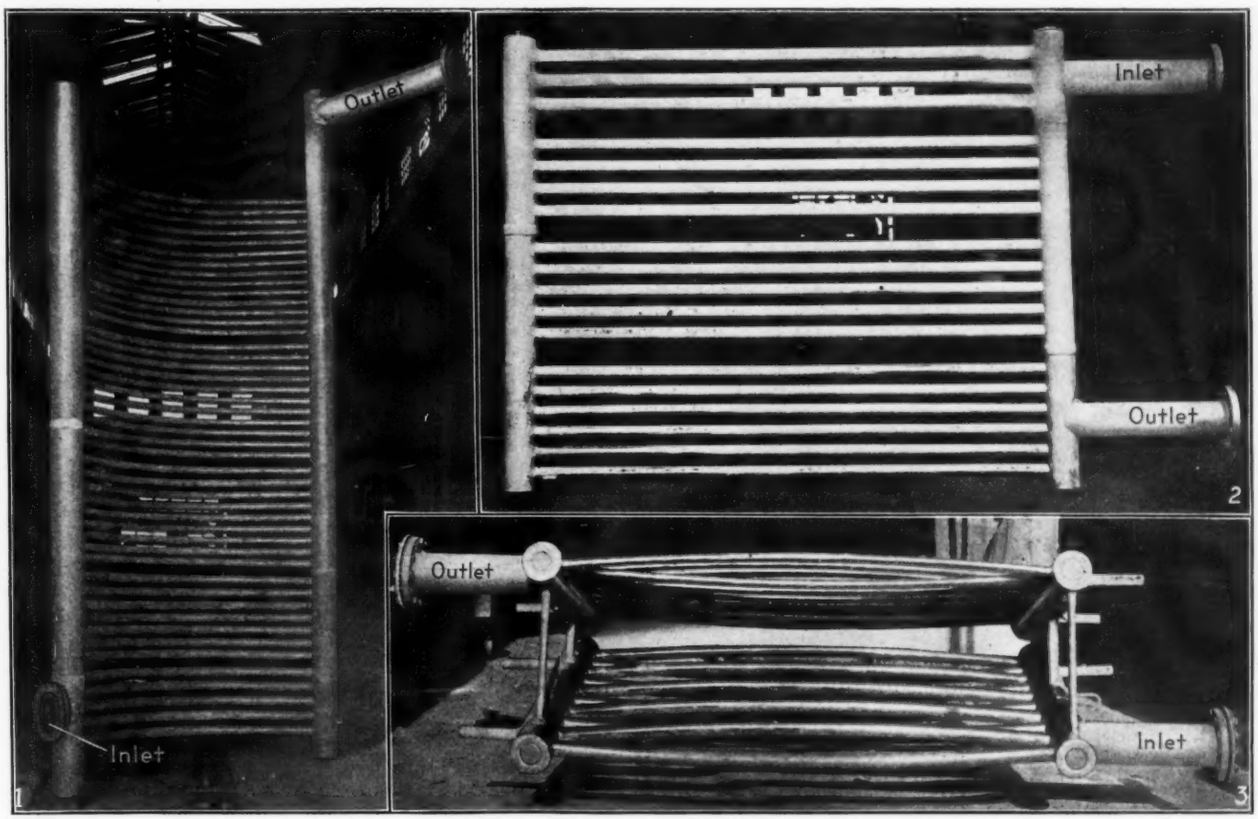
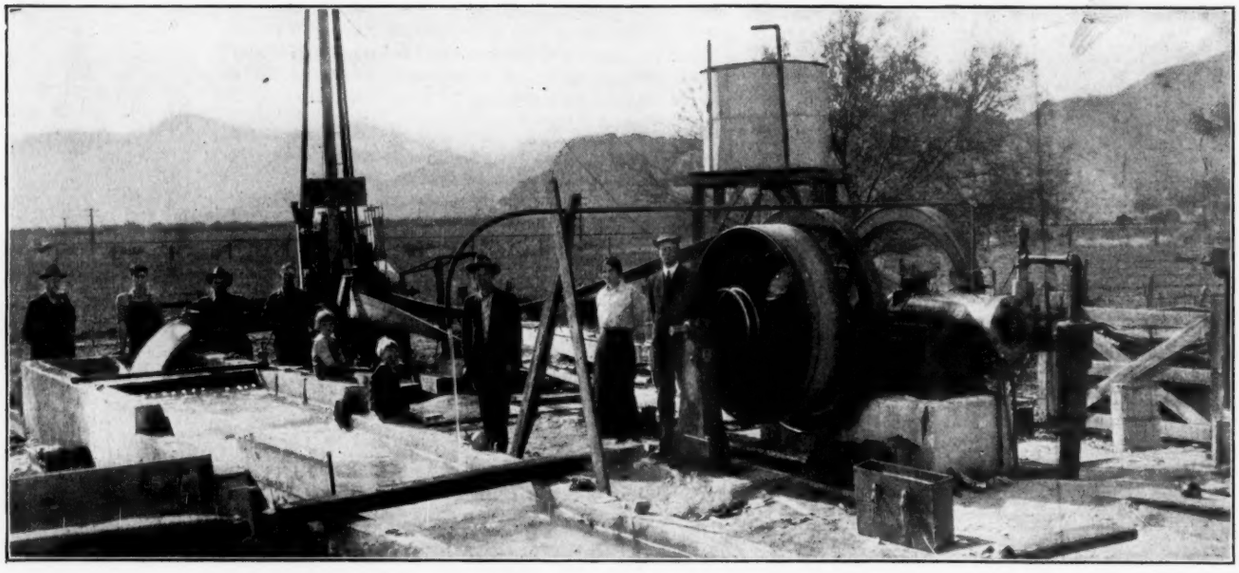


FIG. 1. SUPERHEATER DESIGNED FOR WICKES VERTICAL BOILER. FIG. 2. DESIGN OF SUPERHEATER USED WITH EDGE MOOR AND BABCOCK & WILCOX TYPE OF BOILERS. FIG. 3. SUPERHEATER FOR BADENHAUSEN BOILER

large weight involved, the putty method is hardly applicable, but if the motor be raised from its supports and suspended from an overhead beam by a fall or tackle, it will run smoothly even though considerably out of balance. This is because the shaft is then free to rotate about its center of gyration. The actual shaft center—in fact, the entire machine—moves in a circle around the center of gyration. This movement is so smooth, however, that it is scarcely perceptible.

Pumping Plant for Small Irrigation Projects

A type of pumping plant which is becoming extensively adopted in the Southwest is shown in the accompanying illustration. Plants like this are used both for small public water-supplies and on irrigation projects.



IRRIGATION PUMPING PLANT OF GUILD FARMS CO., NEAR TUCSON, ARIZ.

The use of these small isolated plants for pumping ground waters makes possible the reclamation of many thousands of acres of land in California, Arizona, New Mexico and western Texas, which are not and probably never could be included in projects larger than a few hundred acres.

The plant illustrated is typical of the most recent development in this branch of irrigation engineering. It was completed in January for the Guild Farms Co. for the irrigation of about 380 acres of alfalfa and grain lands situated 20 mi. northwest of Tucson, Ariz., in the Santa Cruz valley. The pumping machinery, engine, etc., cost about $4,000 and the well, including drilling and casing with hard-steel stove pipe, 12-gage, cost $7.50 per ft. for the 24-in. section and $5.25 per ft. for the 16-in. section. The total depth of the well is 170 ft., of which 70 ft. is 24 in. and below that 16 in. The cost of the water-supply was therefore about $5,000.

The normal level of the water in the well is 53 ft. below the surface. The pump is a two-stage 24-in. centrifugal running at 980 r.p.m. on a vertical shaft in the well, 70 ft. below the surface of the ground. These pumps are made by the Layne & Bowler Co., Houston, Tex. The plant described was installed by the Schweitzer Machine Co., of Tucson and Phœnix, Ariz.

The power is a 60-hp. 4-cycle oil engine made by the Western Gas Engine Co., Los Angeles, Calif., of which the fuel consumption is 6 gal. per hr. (38 deg. Baumé). The well shown was tested by continuous pumping at the rate of 1,900 gal. per min. for 8 days, during which the water was drawn down 17 ft., making the average lift 61 ft. The length of the suction pipe was made 35 ft. The water is pumped into a concrete flume having a permanent weir. Water for domestic purposes (stored in the 1,000-gal. tank shown in the background) and for cooling the engine cylinder is pumped from the flume by means of a 2½-in. centrifugal pump. The pump and engine were subsequently housed at an additional cost of about $200.

It has been found that success in this class of irrigation requires the services of experienced engineers, and the farmers and ranchers are coming to all this. The preliminary work requires a thorough knowledge of the groundwater conditions of the locality; and the selection and installing of the proper equipment have become a recognized local branch of engineering.

Occasionally groups of pumping plants like the one described are operated by electric motors from a central station. The Tucson Farms Co. operates about 80 pumping plants from the central power station of the Tucson Gas, Electric Light and Power Co. The motor is usually mounted on the vertical shaft which carries the pump.

Converting Pressure (P) into Head (H) in Feet is accomplished by the same method for steam or other gas as for fluids, by the use as a multiplier of a constant proportional to the weight per cubic foot of the gas or fluid. The common constant for water is 2.3, or P (pressure per square inch) × 2.3 (constant) = H (head in feet). This constant is determined by the number of times the weight of 1 cu.ft. of the gas or fluid will divide into 144, the dividend 144 being the height in feet of a column 1 sq.in. cross-sectional area to contain 1 cu.ft., or 1,728 cu.in. Therefore if 1 cu.ft. of water, or a column 1 sq.in. cross-sectional area and 1,728 in high (144 ft.), weighs 62.5 lb., the pressure sustained on the (1 sq.in.) base of this column 144 ft. high is 62.5 lb. and the pressure per foot is 144 ÷ 62.5 = 2.304 (or 2.3) lb. per ft. As the specific gravity varies with temperature changes, the exact constant must be determined for a given temperature. By the use of the specific gravity of steam or other gas, its head in feet per pound, or feet to produce 1 lb. pressure may be determined, or $H = \frac{P \times 144}{D}$.

Design of a Water Brake

By Winslow H. Herschel*

SYNOPSIS—A description of the design and use of a water brake contrived for testing a turbine.

The writer was recently called upon to design a 500-kv.-a. 100-per cent. power factor, or 745 b.hp., turbine with 50-per cent. overload capacity. The maximum load to be measured on test was somewhat over 1,100 b.hp. As no generator was available, it was necessary to design a dynamometer of sufficient capacity to absorb this load.

When it is a question of small amounts of power and slow speeds, a friction brake may be employed in which the load is applied by brake shoes, ropes or bands bearing on the circumference of a wheel. If the heat developed is considerable, the wheel must be water-cooled, but this becomes impracticable for very large loads. The fan dynamometer is also useful for small powers and has been used to some extent for testing automobile engines.

Not every dynamometer that will measure large amounts of power is suitable for use with steam turbines. The torsion dynamometer could not be used, because it measures but does not absorb the power, though this type of transmission dynamometer is well-adapted for use on steamers where a long propeller shaft is available. The Alden dynamometer will also measure very large powers, but not at the high speeds used with steam turbines. A cast-iron disk is mounted on the shaft and is surrounded by a casing to which are attached copper plates that lie one on either side of the disk. The friction between the copper plates and the disk is varied by the pressure of the water admitted to the casing. Since the disk must be of cast iron, the peripheral speed is limited to about 7,000 ft. per min. The power is limited by the heat that can pass through the copper plates, so that the large-capacity brakes require more than one disk. One with four 60-in. disks[1] absorbed 3,000 hp. at a speed of 225 r.p.m.

Water Brake Dynamometer

For high-power high-speed steam turbines the water brake is thus found to be the only form of dynamometer left to consider. In 1877 William Froude read a paper before the Institution of Mechanical Engineers, "On a New Dynamometer for Measuring the Power Delivered to the Screws of Large Ships." Froude employed a sort of turbine wheel rotating within a casing full of water, held stationary by a lever pressing against a spring. This represents the general features of a water brake, but it is not essential that the rotor should be of so complicated a form. The Westinghouse Machine Co. has used disks with teeth or blading on the periphery, but for the sake of reproducibility and easy calculation of the power that will be absorbed it is preferable to use plain disks.

The simplest water brake consists of one or more smooth disks mounted on a shaft direct-connected to the turbine shaft and inclosed in a casing. In our brake the tendency of the casing to revolve was resisted by a lever fastened to the casing and acting on an ordinary platform scales, in place of the spring used in Froude's dynamometer. For convenience in calculating the horsepower the length of lever from the center of the water brake shaft to the point where the lever acted on the scales was made 5 ft. 3 in., so that the power could be calculated by the formula,

$$B.hp. = \frac{W(2\pi R)n}{33{,}000} = \frac{Wn}{1{,}000} \qquad (1)$$

where

W = Reading of platform scales, in lb.;
n = Revolutions per minute, of turbine and brake, from tachometer;
R = Length of lever.

In any water brake the water must be supplied to the space between the rotor and the casing in sufficient quantity to prevent the formation of steam in any considerable amount. The required rate of feed of water may be calculated from the formula,

$$Q = \frac{b.hp.(33{,}000)}{778(t_2 - t_1)8.32} \qquad (2)$$

where

Q = Rate of feed of water, in U. S. gallons per min.;
t_1 = Temperature of water at inlet, in degrees F.;
t_2 = Temperature of water at outlet, in degrees F.;
778 = The mechanical equivalent of heat.

It is interesting to note that Professor Rateau used a water brake to find the mechanical equivalent of heat, by regarding that as the unknown quantity in equation 2 and measuring the feed as well as the rise in temperature of the water and the power absorbed.

To find the rate of feed in our case, we must assume values for the temperatures. If we take the inlet temperature as 80 and the outlet temperature as 180, so as to avoid the boiling point of water by a safe margin, we shall have a rise of temperature of 100 deg. F. Introducing this value and that of 1,100 for the power into equation 2, we have

$$Q = \frac{1{,}100 \times 33{,}000}{778 \times 100 \times 8.32} = 56 \textit{ gal. per min.}$$

This shows that care must be taken to provide for an ample supply of water. Furthermore, since the rotor acts like a centrifugal pump, the water must be admitted to the compartment containing the rotor at a point near the axis of rotation, where the pressure is low. The power absorbed is increased by throttling the water as it escapes from the casing, thus increasing the width of the ring of water that is thrown to the circumference. The limit of power is reached when the casing is full of water and the rate of flow is not sufficient to prevent the formation of steam.

The water brake designed to meet these requirements consisted of six smooth disks 24 in. diameter, such as are used for cutting slate. Each rotated in a separate compartment, with a ½-in. clearance between the sides of the disk and the walls of the compartment. Between each pair of disk compartments was an annular space 1¼ in. wide through which water was admitted, entering

*Bureau of Standards, Washington, D. C.

[1] "Electrical World," Oct. 31, 1908, p. 945.

through the narrow clearance between the side walls of the compartments and the hubs of the disks. The casing was supported on roller bearings so as to be free to move with a change of load. To equalize the supply to the annular cells, the water was pumped into a tank placed directly above the casing and supported on it, and there was a pipe connection from this tank to each cell.

Froude stated in his paper that of two dynamometers of different size, "their respective moments of reaction, with the same speed of rotation in each, should be as the fifth powers of their respective dimensions." This rule would, however, not suffice to calculate the dimensions of a dynamometer of a new type. The complete formula, equation 3, is given by Roetscher.[2]

$$B.hp. = \frac{D^{5.366} n^{2.66}}{4.704 \times 10^{16}} \qquad (3)$$

where

$B.hp.$ = Maximum power which can be absorbed by one disk;
D = Diameter of disk in centimeters;
n = Revolutions per minute.

This formula was derived from tests made with a brake having perforated disks, while our disks were without perforations, so that it seemed possible that equation 3 would give a power somewhat in excess of what could be obtained with our water brake. If we take D equal to 24 in., or 61 centimeters, and n equal to 3,600, the normal speed of our turbine, the equation gives 230 hp. for one disk, or 1,380 b.hp. for the six disks. The excess over 1,110 b.hp. seemed sufficient to allow for any lack of power of the brake or superabundance of power of the turbine.

Lifting the Water

The centrifugal pump employed to circulate the condensing water as well as to raise water to the water-brake tank was supposed to run at 410 r.p.m., but owing to a leaky suction pipe and lack of a foot valve it was found necessary to increase the speed to 540 r.p.m. The discharge pipe from the condenser was throttled from 8 down to 4 in. diameter at the end where it discharged into the open air. After these changes had been made, it proved possible to raise the water through a 2½-in. pipe to the water-brake tank.

The absence of a foot valve and the impracticability of applying one below low tide caused considerable trouble before a method was found for starting the centrifugal pump. A piston pump belonging to a steam-engine condenser was connected with the suction pipe of the centrifugal pump at a point a few feet nearer the intake. Futile attempts were made to start the flow in the suction pipe by means of the piston pump and then keep the water flowing by means of the centrifugal pump after the piston pump was stopped. An ejector proved successful as a means for starting the centrifugal pump, but it was discarded as too wasteful of steam. The final solution was to place a flap over the 4-in. end of the discharge pipe, already mentioned, and exhaust the air through a pipe attached at one end to the priming hole of the centrifugal pump and at the other to the exhaust pipe of the turbine.

The supply of water to the water brake was, to the end, somewhat unreliable, owing to the increase in suction head at low tide. When at times the supply would entirely fail, the water in the water brake would turn to steam, and when the turbine was run without a governor, the consequent racing was a real source of danger. When the tachometer showed a rapid increase of speed and the needle appeared to be about to start around on a second lap, we knew that there was no time to be lost in closing the throttle.

Considerable trouble was experienced with the water-brake thrust bearings, which were replaced first by ball bearings and finally by roller bearings similar to those that had given satisfaction on the turbine from the beginning. Otherwise the water brake gave complete satisfaction. Trouble was experienced at times in trying to weigh large loads at low speeds, but as long as the normal speed of 3,600 r.p.m. was maintained there was no difficulty, although the load varied from 49 to 1,326 b.hp. It will be noticed that the maximum power measured was very close to the calculated maximum capacity of the brake, 1,380 b.hp. No measurements were made of the temperature or amount of cooling water used, but it is safe to say that a considerable saving was effected by using salt water instead of water from the city mains.

In the course of the tests the question arose as to the proper method of taking observations. It is of course impossible to keep the readings of the scales and of the tachometer absolutely constant by adjusting the load on the water brake. There will be unavoidable variations in boiler pressure, and it is safe to assume that readings of steam conditions at regular intervals of time will give the best average values. The question to be decided is whether readings for horsepower must be made at the same instant as readings for steam conditions. It is evident that readings of W and n in equation 1 must be taken simultaneously. But to take readings of speed and torque at regular intervals involves taking them during changes of speed, and it seems preferable to take readings only when the scales and tachometer are steady and the speed is normal, although this necessitates taking readings at irregular intervals of time. Apparently the reason why this method appears wrong to many engineers is that they assume that the consumption will vary with the speed as with the steam engine or hydraulic turbine. Yet it has been proved by theory and by test that the weight of steam that will pass through a steam turbine is independent of the speed of revolution.

The objection to taking readings at regular intervals of time is that when the speed is changing, the horsepower indicated would be too small by the amount expended in accelerating the rotor on a rising speed, and too large by the amount given out by the rotor on a falling speed. Although the few tests made by both methods failed to indicate any substantial difference in result, the method of taking readings at regular intervals was abandoned on account of being less convenient, as well as having no theoretical advantage.

[2] F. Roetscher, "Mitteilungen über Forschungsarbeiten," No. 50, p. 37.

Large Drop in Pressure per Unit of Length suggests a small pipe and high velocity, with consequent decrease in condensation loss, but a point is soon reached where the economy of the smaller size of pipe is more than offset by the pressure drop and friction loss. Some drop in pressure is necessary, otherwise there would be no flow, but there is no fixed general rule for determining the drop most suitable even for a given set of conditions. In current practice it ranges from a fraction of 1 lb. to 4 lb. per sq.in. per 100 ft. of pipe, with an average between 1 and 2 lb.

Editorials

Sulphur Content in Steel

Users of steel have always regarded sulphur as a particularly objectionable impurity, especially when the sheet containing it is liable to be overheated. The specifications of the American Society for Testing Materials, the American Society of Mechanical Engineers and the Massachusetts Board of Boiler Rules allow not over 0.04 per cent. in firebox and 0.05 per cent. in flange steel. Practically all writers on metallurgy agree that sulphur in steel is bad.

And yet Doctor Unger, director of the Research Department of the Carnegie Steel Co., in a series of experiments the results of which are given briefly on pages 144 to 146 of this issue, finds no difference in the behavior of specimens alike in other respects, the sulphur content of which varied from 0.03 to 0.18 per cent. With its highest value nearly $^1/_{500}$ of the weight of the sample was sulphur, and yet of the specimens exhibited it was impossible to pick out from their appearance, after bending, flattening, upsetting and torturing of all kinds, hot and cold, those which had the greater percentage of this impurity.

Have the authorities been mistaken all this time? Is the universal apprehension with regard to sulphur groundless, or has Doctor Unger performed a feat in metallurgical legerdemain, producing abnormal results which may not be depended upon to reproduce themselves in common usage? There certainly ought to be some basis for the well-grounded belief among the men who work and use steel, that an excess of sulphur tends to make the material hot-short. The samples tested by Doctor Unger were very low in other impurities: Carbon, 0.09, while the specifications of the societies referred to allow 0.25 and 0.30; manganese, 0.43, with an allowed percentage of 0.30 to 0.60; phosphorus 0.012, with from 0.035 to 0.050 allowed

It will be interesting to see what future tests develop as to the effect of excessive amounts of sulphur in combination with normal and even abnormal amounts of other impurities.

Massachusetts Board of Boiler Rules and A. S. M. E. Code

With respect to the attitude of the Massachusetts Board of Boiler Rules toward the Boiler Code of the American Society of Mechanical Engineers, touched upon in these columns last week, it has been suggested that the differences are not mainly of an engineering character, but that the repulsion between the two bodies is due more to personal animosity and commercial avariciousness than to honest difference of conviction as to engineering practice.

The chairman of the code committee, who used to be a member of the Board of Boiler Rules, is an exceptionally forceful character, but has never been cited as a model of tactfulness. It may be that a code produced under somebody else's leadership would have been more palatable to the Bay State.

There are those, too, who say that the boiler makers of New England are not over anxious for accord between the Massachusetts rules and those of the rest of the country; that they take the ground that it is better for them to have the Massachusetts requirements different from those in force in the territories of their competitors. They are fixed to meet those requirements. Ninety per cent. of their trade is in New England, where a "Massachusetts Standard" boiler is the real thing whether the state requires it or not. By requiring it Massachusetts keeps out their cheap competitors, and the favor in which the boiler is held throughout New England does the same thing for them in states that have no boiler regulations. Outside manufacturers are obliged to carry special stocks and to go through a lot of red tape, which has become routine to the New England man, in order to take and fill a contract for this high-grade boiler, but the New England boiler maker has so little business outside of that corner of the country that he does not have to carry a multiplicity of stock or cultivate a costly acquaintance with the requirements of many boards to meet a miscellaneous demand.

If this should prove to be the fact, it would be well to call the attention of the New England user of steam boilers to the fact that he is being exploited. If the state is going to require him to use a boiler of a special type which only a few boiler makers, local to New England, are equipped to build to the best advantage, it will cost him more money than it would if he could use a boiler that any good boiler maker in the country could bid upon on equal terms.

And there is another and deeper phase to the question. Whatever the laws of the commonwealth may be, whatever the Board of Boiler Rules may require, no court will uphold an action of a state official toward preventing the use of a boiler which can be shown to the satisfaction of the court to be reasonably safe, and a boiler built in conformity with the Code of the American Society of Mechanical Engineers would be so considered by any court informed of the character of the society and of the men and institutions that formulated the Code.

The Brooklyn Ammonia Explosion

Boston, New York and Detroit have recently put in force rules governing the construction, operation and inspection of refrigeration plants, with particular reference to ammonia plants. Chicago has had such rules for a long time. To recall some of the many serious accidents to such plants to prove the need of such rules in all cities is unnecessary.

At public hearings on these rules the question of the minimum capacity of a plant that should be excluded under such rules is one of the most vigorously discussed. Having in mind that the purpose of such regulation is to safeguard the public, reason tells one that the law should

apply to any plant large enough to endanger human life through incompetent construction or management. The explosion of a two-ton, gas-heated absorption plant at Brooklyn, July 13, in which five persons were killed and the building completely wrecked is, unfortunately, an object lesson on this exclusion argument. Here was a small plant, supposed to be somewhat automatic, left in care of a boy. The charge of ammonia was of course small. We understand that a week or more ago the relief, or safety, valve developed trouble; it had been troublesome anyway, so he removed it and plugged the pipe. Like every true boy, he went fishing, and while he was away the explosion came.

One city official stated to us that it appeared as though it would be necessary to require that only licensed operators be put in charge of such plants. Regarding these plants as instruments of destruction if improperly cared for (and the public and the city officials will so regard them), the most expedient course is to make it compulsory to have licensed operators in charge. Those who remember what transpired at the hearings on the present ammonia safety rules of Massachusetts recall that this very phase of the subject was heatedly contested. One must not, of course, forget that the type of plant or system is an important consideration in the discussion of the minimum capacity at which a plant should be allowed to run without a licensed operator.

It is to be presumed that New York City will hold hearings on this explosion, and makers of small refrigerating machines would do well to prepare their arguments now, if they are not already prepared.

This explosion is indeed interesting in its relation to the decomposition of ammonia. From the facts available one is inclined to believe that two explosions occurred—the initial one, which relieved the ammonia and started rapid decomposition, and the more destructive one, which was the combustion of the explosive mixture of decomposed ammonia and air.

⁂

Fractionation and Designation of Lubricating Oils

One following closely the various journals, papers, bulletins, etc., that go to make up recent technical literature of interest to power-plant men cannot but notice the interest in lubrication and lubricating oils. 'Tis a good sign, for no one will question the need of investigation into both subjects. Among many, the lubricating-oil business in the past has been looked upon as akin to the patent-medicine industry. Scientific research will banish this attitude.

Although little used by engineers interested in lubrication, Bulletin Number 114 of the Bureau of Mines, on "The Manufacture of Gasoline and Benzene-Toluene from Petroleum and Other Hydrocarbons," by W. F. Rittman, C. B. Dutton and E. W. Dean, with a bibliography compiled by M. S. Howard, contains results of investigations into the distillation of crude oils into their component oils and the reuniting of the components in whole or in part that throw much light upon the possibilities of lubricating-oil manufacture; but, as is usual, the question arises as to whether scientific possibilities are feasible commercially. J. G. O'Neill has a paper in the May, 1916, "Journal" of the American Society of Naval Engineers, on the "Fractional Distillation of Lubricating Oils," published in full in *Power* for July 18, that contains considerable of value in lubricating-oil research work.

Considered from the chief engineer's office the ideal oil is one that will give the longest service in some particular place with the least unfavorable change in viscosity, specific gravity, flash point and temperature of vaporization. Mr. O'Neill in the last paragraph of his paper (page 112, *Power,* July 18) well states what the engineer is most interested in relative to oils:

> From the mechanical viewpoint, provided the oil is well refined, we are interested only in the viscosity of a lubricating oil (latest researches show that the viscosity controls the coefficient of friction) and the maintaining of this viscosity without change when in use. It is well known to the service what the viscosity of the lubricating oils should be for the different purposes intended, but heretofore there were no known methods which would indicate between equally well-refined oils which would longest retain their viscosity without change when subjected to severe use. The knowledge that shows a lubricating oil will retain its viscosity without change when subjected to severe use is then equally as valuable, if not more so, than the knowledge of the original viscosity. The maintaining of the viscosity without change when in service is dependent on the following factors: Mineral lubricating oils should be compounded from oils which vaporize within narrow limits, and from oils having relatively the same viscosity, specific gravity and flash and fire points.

The last sentence is most significant. That work along this line will be done is likely, for there are plain indications that, among large consumers at least, it is becoming common to inquire more closely than heretofore into the properties and stability of oils for various services about the plant.

One engineer competent to speak stated to us recently that investigation into the manufacture of fractional distillates of crudes had shown that the carbon and hydrogen content of the distillates and of the residues was a true indication of the lubricating quality of an oil. This man suggests a discussion of the advantages and disadvantages of so designating oils used in the trade, as such manner of designation would give a ready indication of whether the oil was a saturated or an unsaturated hydrocarbon, and of its viscosity, specific gravity, volatility and other properties. We should be pleased to have such discussion submitted.

⁂

Some men feel worse when they overflow the pail of milk of human kindness than when the oil filter runs over.

⁂

Announcements that this or that station is obtaining thermal efficiencies of fifteen to nearly eighteen per cent. must convince the elusive heat units that this is indeed a cold world.

⁂

In the design of any piece of mechanical apparatus the engineer is always confronted with the problem of reducing friction to a minimum. In electrical machinery it is not friction alone, but also eddy currents which are produced in the armature core, the polepieces, and the armature conductors if they are of large cross-section, that must be kept to a minimum if the machine is to operate at a high efficiency. In some cases bearing currents that circulate from the armature shaft through the frame of the machine must be contended with. In alternating-current work the prevention of eddy currents requires even more attention than in direct current. On another page of this issue Mr. Cross describes the various causes of eddy current and the means that are employed to prevent them, and how in some cases they may be used to an advantage, notably the damping of electrical instruments.

Correspondence

Margin of Power in Internal-Combustion Engines

The article by R. E. Mathot in the June 20 issue, discussing the margin of power in internal-combustion engines, seems worthy of comment. The part upon which I desire to comment is that which refers to Diesel engine rating.

Mr. Mathot emphasizes the problem of running the oil engine on light load. He states that to run the engine on light load is detrimental to the complete combustion of the fuel. There is no denying that an engine under one-third load often shows signs of incomplete combustion. It can be safely denied, however, that this condition is due to the light load. An excess of injection air might be the cause. It is hard to see how running the engine too cold can have this result, although I believe the engine should be jacketed to keep it from getting too hot. If this engine will produce a temperature at ignition sufficient to ignite the spray, then the temperature of the engine cannot be the cause of imperfect combustion.

The article says: "This trouble is much more likely to develop when running on oils of a lower flash point or of a higher viscosity. Therefore, the most unsatisfactory oil to work with on light load is the tar oil." An engineer in making such a statement should give his reasons. Generally speaking, it has been my idea that high flash point and high viscosity went together. In Vol. 2, No. 2, of the "Journal" of the American Society of Marine Draftsmen I find that Lieut.-Com. J. J. Hyland in his paper on "Oil Burning" gives a heavy tar oil as having a gravity 1.084 and a flash of 218 deg. If the viscosity of tar oil has any relation to its gravity, as is usually true with fuels, then I would agree with Mr. Mathot on tar oil being most unsatisfactory either for full load or light load in the present engine equipped with any of the conventional fuel valves.

What has the flash point to do with fuel? A fuel of low flash point will not ignite appreciably below the point at which a fuel of high flash point will ignite. The flash point is the point at which the fuel will give off a vapor that will ignite if brought in contact with flame. Gasoline-engine practice shows that a perfect mixture of engine charge will not ignite much below somewhere around 700 deg. F. Dugald Clerk's experiments on the temperature of the charge at the beginning of compression in a running engine show this to be true if the gasoline-engine card be plotted to find its temperature curve.[1] What does the boiling analysis have to do with the fuel? What does the specific gravity have to do with the fuel?

The matter seems to lead to the conclusion that any fuel can be used which can be properly sprayed. If Mr. Mathot had said that for a certain make of oil engine the specifications given should be adhered to in the matter of fuel, no objection could be taken to his remarks. This is something for the maker to tell the users. However, when he gives out such information as general facts, he is misleading the readers who seek information and doing an injustice to those of us who are striving to produce a universal oil engine that can use anything free from sediment, ash, water and acid. As a result of my investigations I am assured that this is possible. True, it calls for some care in the fuel-handling side of the engine. The cost of the fuel valve and fuel pump is a small part of the total cost of the engine, and it will pay to increase the cost of these elements manyfold so that any fuel may be used. When these points are considered, the Diesel is eliminated from the oil engine and all you have left is the ordinary "gas engine."

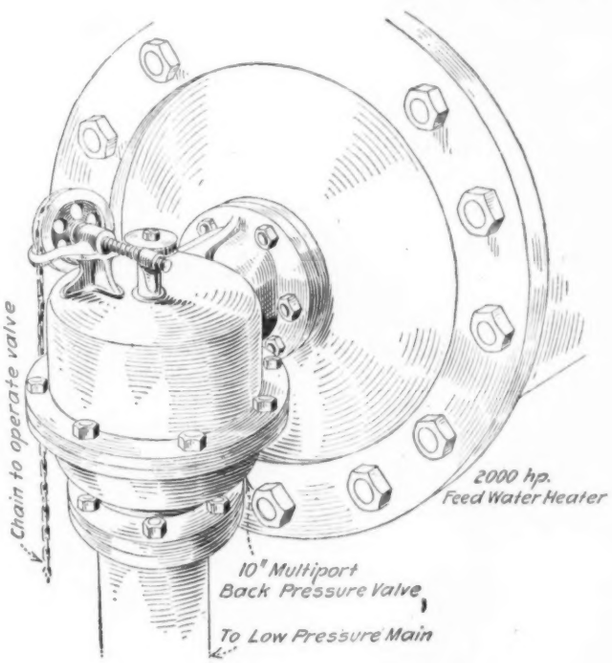
JOHN F. WENTWORTH.

Quincy, Mass.

[1] See "Thermodynamics of the Marine Oil Engine," "Power," Jan. 26, 1915.

Feed-Water Heater Control

This somewhat unusual mode of controlling the steam supply to a closed-type feed-water heater may be of interest. In a manufacturing plant there is use for a lot of steam at 6 to 10 lb. and the auxiliaries, pumps, fan engines, etc., totaling about 400 hp., all exhaust into the low-pressure system. The main engines are compound-condensing, the circulating water being used for boiler feed through an economizer and in the processes.



VALVE TO CONTROL STEAM TO HEATER

The plant operates continuously; the night load varies from 15 to 75 per cent. of the day load, and the Sunday load is 10 per cent. or less and becomes light enough

to be carried by the smaller high-speed unit operating noncondensing. Before the feed-water heater was installed, cold water, which was detrimental to the economizers, had to be used, and at the same time the exhaust from the engine and some of the pumps would escape to the atmosphere.

Exhaust steam was of great value in the processes during the period of greatest demand, and feeding the economizers with 100-deg. water permitted abstracting from the escaping gases a greater amount of heat and it did not seem advisable to so connect a heater that it would take steam continuously. Quite an interesting problem presented itself, some of the factors being: To prevent the waste of exhaust steam during 14 to 16 hours a day; to prevent cold water entering the economizers and to permit a maximum utilization of the exhaust steam in the factory; or in other words, to retain in the system as great a proportion as possible of the heat generated and direct it to useful work and to make the method simple to operate and as nearly automatic as possible.

A 2,000-hp. (rated) closed-type heater was piped so that the feed water passes through it at all times, and a 10-in. "dead-end" steam connection was made to the low-pressure line, the only outlets being the drain for the condensate and an air vent. The multiport back-pressure valve had small spring-loaded valves controlled by gearing and a chain for any desired setting.

The operation is as follows: When there is little use for the low-pressure steam and the pressure rises after the reducing valve has closed, this valve opens automatically and passes the steam to the heater and prevents it escaping to the atmosphere; and when there is no other demand, the loading of the valve is removed and all the steam passes to the heater with little or no back pressure.

The setting of the valve is modified as conditions require and any desired temperature of feed water obtained. The simplicity of the arrangement, and the fact that it is almost automatic, cause it to be very popular with the men, and the absence of sweating and corrosion of the economizers formerly experienced with cold feed water justifies the change, giving enhanced efficiency and considerably greater increase of temperature in the water and a correspondingly greater decrease in temperature of the outlet gases. CHARLES L. WARE.

Maynard, Mass.

Unsafe Water-Heater Piping

A great many accidents have occurred from improperly connected hot-water tanks, or heaters having check valves in the supply lines, or exposed lines becoming frozen up so that there was no relief for steam if formed in the heater. Numerous such installations have been described in the past, and it would be well to have this type of pressure vessel come under the boiler-inspection rules.

Often the heating coils are supplied with steam direct from the boilers, and at starting off everything works first rate; the thermostatic valve admits steam only in amounts sufficient to maintain the correct temperature. All goes well for a time—so well, in fact, that the apparatus ceases to receive much attention; being "automatic," it can take care of itself. After a while conditions begin to alter, the regulating valve gets more or less out of order, and the hand-valve regulation is thought to be good enough. Besides, hot water can be obtained much more quickly thereby; but it is sometimes forgotten and left wide open. No one knows whether the safety valve will blow off or not, or perhaps it has been purposely screwed down and the following conditions prevail:

At 100 lb. boiler pressure the steam temperature is about 337 deg. In the event that no hot water was being drawn and the supply pipe was closed by a check or other valve or by ice, the temperature of the water would soon become the same as the steam and steam would be generated in the tank; and naturally, the older the tank the less secure it is.

The chance for accidents is very slight if the supply line is kept unrestricted. For instance, 30-lb. supply pressure will be counterbalanced by a temperature of 275 deg. F. If the supply line is free, all excess pressure in the tank will simply find relief by overcoming the supply pressure and backing out into the main.

A large percentage of these accidents are attributed to stoppage in the water-supply line. Several plants have come to notice where check valves have been put in on these lines to prevent hot water backing out along the line and affecting the lead joints and causing expansion and contraction strains that started leaks.

I know of one instance of the kind that resulted in an explosion. Another explosion occurred lately that was caused by the freezing of the supply line, and several persons were seriously injured—one fatally.

Philadelphia, Penn. EDWARD T. BINNS.

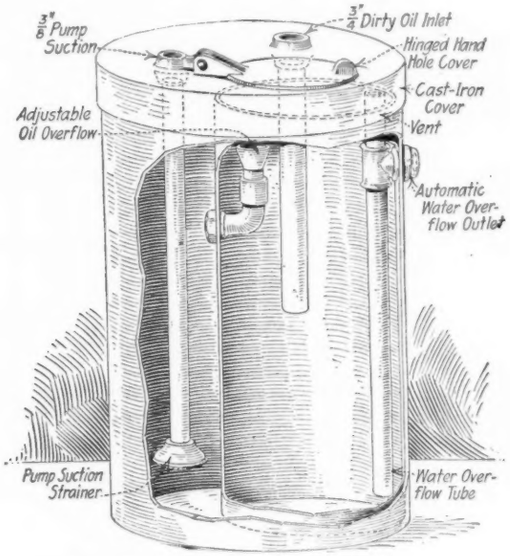
Oil and Water Separator

From time to time articles appear describing home-made apparatus for the power plant. These contrivances are justified only when the equipment on the market is either unsatisfactory for the purpose or prohibitive in price. It is reasonable to believe that a manufacturer who builds several hundred machines of any kind in a year can sell one cheaper than the engineer can make it; otherwise he could not put the machine on the market at all. Besides, the manufacturer has directed the attention of experts to this one particular product—this the engineer cannot afford to do. It carries with it the experience and reputation of a complete organization of specialists—the home-made product is usually the result of one man's experience.

An example of the employment of a home-made contrivance where equipment to exactly fill the requirement was available, was described on page 300 of the issue of Feb. 29, under the title "An Oil and a Money Saver." The oil trap, or separator, there described and illustrated was correct in general principles, but constant attention would be required to keep it operating properly. Several rather serious defects in the design are apparent. In the first place the mixture of oil and water should enter at the top of the separating chamber, or at least at a safe distance from the discharge pipe. Mr. Edney's separator would be improved in this respect by raising the inlet pipe *A* or by putting a vertical baffle plate between inlet *A* and water overflow pipe *C*. The important point, however, is, what happens when the oil flows into the separator to a point above the level *B*? The mixture

of oil and water will force the water out of the overflow pipe until the water is out; then oil will flow over to the sewer. It is probable that the oil would first flow over the dam, or partition, before the combined column of oil and water would balance the column of water in the overflow pipe. In either case part of the oil will probably be lost unless the engineer watches the trap mighty closely.

A separator, to be worthy of a place in the modern power plant, must be automatic in action as well as efficient. To be automatic, it is necessary that the oil and



NEAT AND EFFICIENT OIL SEPARATOR

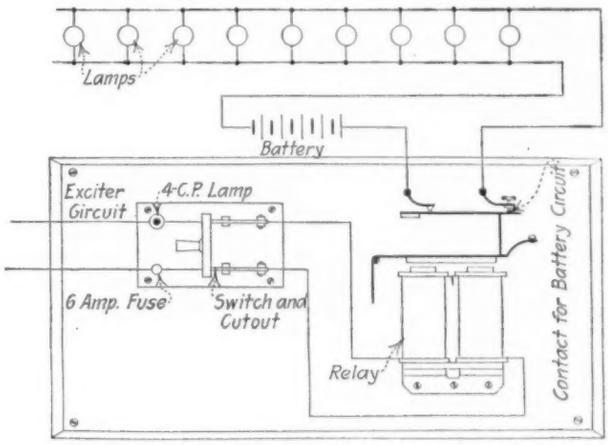
water be maintained at definite levels and that the relation between these levels be adjustable to allow for handling oils of different specific gravities. The principle is that of a U-tube, in one leg of which is a mixture of oil and water and in the other leg water only. The differential height of the oil-and-water leg above that of the water leg is controlled by overflow openings, one of which is fixed and the other capable of adjustment vertically and is the means of carrying the water seal over the discharge opening at any level advisable for the best operating conditions.

The separator illustrated is entirely automatic, and has the necessary adjustment for oil of any specific gravity, by adjusting the water seal and varying the level of oil in the separating compartment.

Milwaukee, Wis. WALTER J. OETTINGER.

Emergency Lighting System

As a precaution against my plant being left in darkness, due to the failure of generators, exciters or station transformers, I constructed and installed the following single combination: Taking an ordinary electric door bell, I connected the leads from the two actuating magnet coils to the two terminal posts on the bell base, thus converting it into a single-stroke bell, which I used as a relay. Next I made a contact, or switch, from a brass spring and a screw binding post from an ordinary dry cell, linking the contact to the end of the relay magnet, as is shown in the illustration. This switch is in series with a circuit of 6-volt, 10-cp. Mazda battery lamps and a 6-volt storage battery. The lamps are placed at each engine throttle, the gage board, the switchboard and in the boiler room. The current to actuate the relay is taken from the exciter circuit, passing through a main-line cutout and switch, such as is used for house lighting. A 4-cp. carbon lamp is placed in series with the relay,



RELAY AND BATTERY LAMP CONNECTIONS

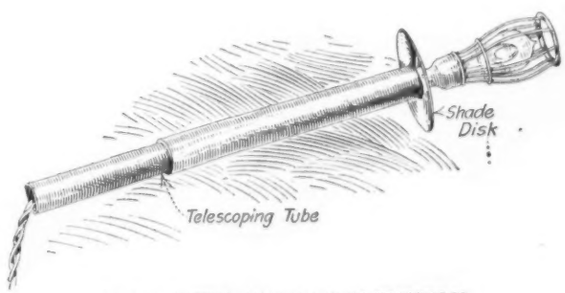
being screwed into one side of the cutout, the other side containing a 6-amp. fuse plug.

The action is as follows: The direct current from the exciter busbars passes through the magnet coils; this attracts the relay armature, opening the battery circuit, which is the normal running position. Should the exciter current fail for any reason, the magnet coils will release the relay armature, which will close the contact on the battery circuit and light the battery lamps. Or it may be that the station lights fail and there is still current in the exciter circuit; then the relay is caused to open by opening the main-line switch by hand.

Lakeland, Fla. GROVER G. LONG.

Portable Extension Lamp

One of the most useful special appliances for general plant work is a portable extension electric light for lighting inaccessible places. For instance, we are able to light up very clearly the interior of our boilers for



LAMP WITH EXTENSION HANDLE

inspection and when cleaning, and for illuminating water and sump tanks.

The device consists of a standard electric-light socket, and a lamp and guard attached to the end of a long adjustable rod, arranged so that it can be lengthened or shortened by sliding one smaller section within the other. The hollow stem carries the wires to the light.

It was found desirable to place at the base of the light a small disk so that the glare would not strike the observer, who is usually at the other end of the rod. The extension rods are each 6 ft. long, so that an effective maximum range of about 12 ft. is secured.

Philadelphia, Penn. M. A. SALLER.

Stopping Furnace Air Leaks with Coal Tar

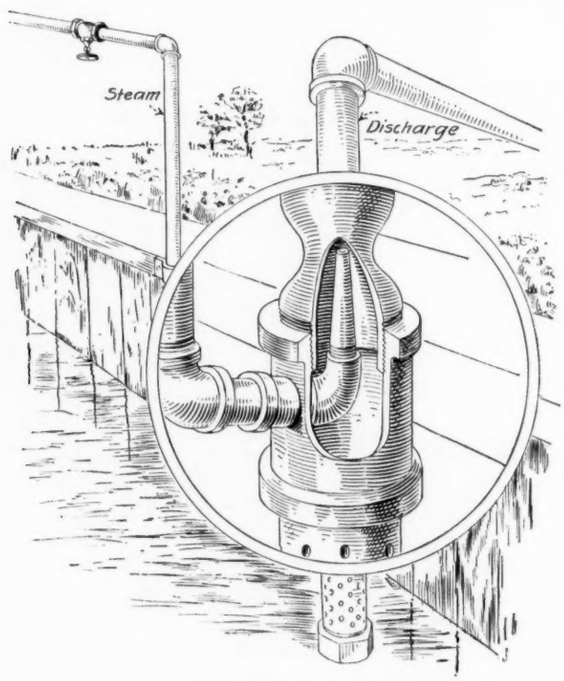
I have tried coal tar and found it to be satisfactory for stopping air leaks in the brickwork of a boiler furnace. First I went over the setting with a ball of asbestos wicking and filled all of the cracks; then I began to apply the coal tar with a paint brush and continued one coat of tar each day until there were five coats covering the brick walls of the furnace.

The furnace is that of a 300-hp. boiler and was being fired at the time of painting, so there was sufficient heat on the outside of the furnace walls to cause the brick to take up the tar. The surface is pliable but not sticky. Coal tar is not costly and is not as crude as one might imagine. The good effect on the fire was noticed as the first coat of tar was applied. J. S. SHEFFIELD.

Hattiesburg, Miss.

Home-Made Ejector Pump

I have used a lot of home-made ejectors and find the one illustrated the best of all. It can be made from ds and ends to be found about the plant. The tapered



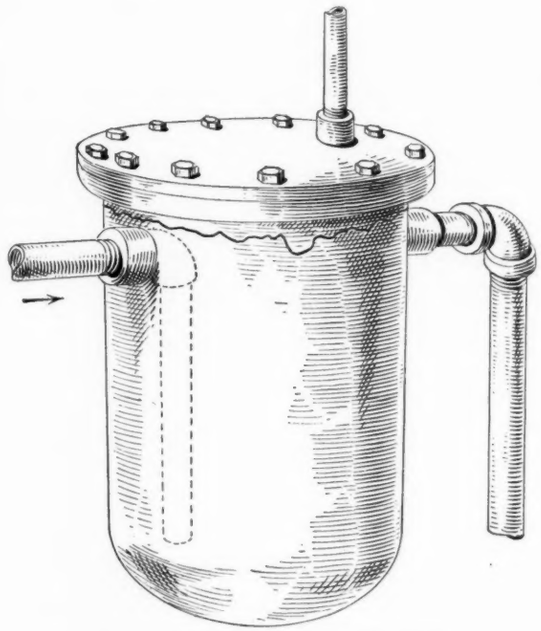
IMPROVED EJECTOR DESIGN

nozzle and the taper or contraction drawn in the discharge pipe make a great difference in the working. Engineers often have use for an ejector, and find it a convenient thing to have about the plant to meet emergencies. F. G. CLARK.

Summit Hill, Penn.

Two Blowoff Tanks Give Way

Within a few days of each other two blowoff tanks of similar design exploded in St. Louis, and in each instance the engineer lost his life. One was at the Imperial Laundry and the other at the American Pape



TYPE OF BLOWOFF TANK USED

Products Co. The tanks were of cast iron with covers bolted on, as shown in the illustration.

In the laundry the cover broke, and the only change or repair made after the accident was to replace the cast-iron cover with one made of steel. That this is wrong is proved by the accident at the paper company's plant, where the body of the tank broke just below the flange, showing that if the cover is able to withstand the pressure, the tank body may not be and the damage may be greater from a high pressure in the tank. In the second case the cover was blown through the roof and fell about 90 ft. away.

It is certainly the business of somebody about the plant to see that the blowoff piping and tanks are in a safe condition and provided with ample and unobstructed vents to the atmosphere. VICTOR J. AZBE.

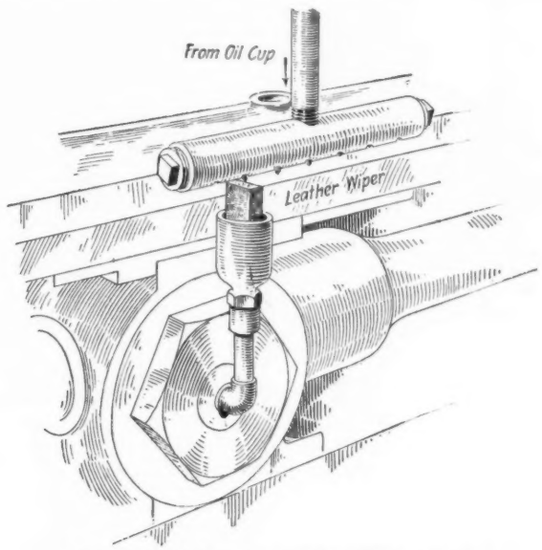
St. Louis, Mo.

Crosshead-Pin Oiling Device

During the erection of an engine that was to be equipped with an unusually efficient oiling system, it was decided to replace the crosshead-pin oiling device with one that could be easily adjusted to give any necessary flow of oil.

The trick was done so simply and the apparatus was so easily made with tools and materials at hand that it seems worth passing on. Instead of a system of swinging telescoping piping, which is frequently used for this purpose, the vertical pipe leading from the oil cup mounted on the guide above the crosshead was screwed into the side of another pipe, which was parallel to the line of the crosshead travel. Both ends were

tapped out and plugged so as to retain the oil and maintain a smooth surface on its under side, where a row of small holes had been drilled. An open cup with a wiper set in it and tapped into the crosshead pin to the usual oil hole completed the device. Its advantages are simplicity, wide range of oil feed possible and cheapness. By increasing the length of the horizontal pipe, any necessary feed can be easily obtained if the first trial does not allow of enough oil.



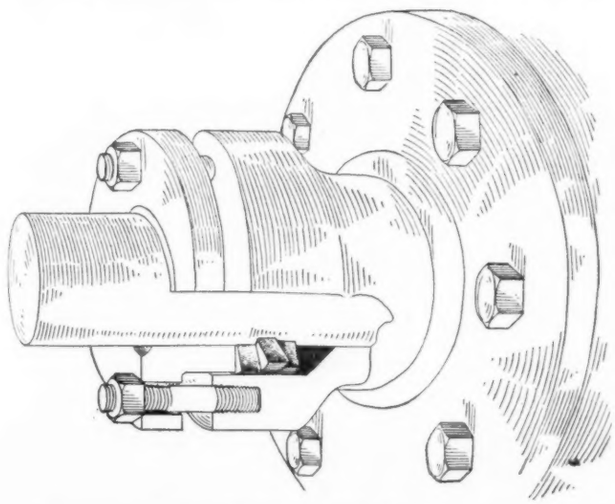
ARRANGEMENT OF CROSSHEAD OILER

In the arrangement mentioned the vertical feed pipe was ¼ in. diameter and the horizontal feed pipe ½ in. to allow stock for drilling and tapping the hole for the vertical pipe. This horizontal pipe was about 4 in. long and proved to be long enough to feed plenty of oil.

Hamilton, Ill. H. B. McDermid.

Packing for Centrifugal Pump

A centrifugal pump in a brewery, used for pumping hot mash from the kettles to vats about 100 ft. above, gave trouble on account of packing not holding. Although metallic, rubber, flax and other kinds had been tried, the mash squirted out and many barrels of this semi-liquid was lost each day. The packing burned out and had to be renewed daily. The pump is operated by a 2-hp. direct-connected motor at 500 r.p.m. 24 hr. per day and has a 3-in. suction and 2-in. discharge pipe.



RINGS OF FIBER FOR PACKING

It occurred to the engineer that since fiber gaskets are used with good results on high-pressure elevator accumulators handling cold water, it was worth a trial in this case, so three rings of ¼-in. fiber were cut to fit and put in after the bottom part of the stuffing-box had been filled with lead to make a flat seat instead of beveled, as shown.

The result was entirely satisfactory as the pump has now been running for two months without the need of repacking it once. The fiber expands with the liquid and also resists the heat. W. T. Osborn.

Newark, N. J.

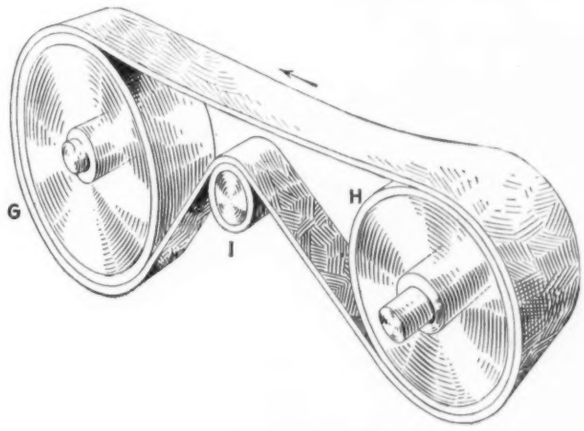
Mica for Hot Bearings

I have found that a small quantity of pulverized mica, fed into a bearing that is getting overheated, helps to hold it and sometimes causes it to cool down considerably and at the same time stops any cutting of the bearing or shaft. F. F. Sengstock.

Chicago, Ill.

Main Drive Benefited by Idler

A 34-in. main belt slipped badly, and it was necessary to pull it up "like a fiddle string" to make it pull the load, and occasionally some sort of dope had to be applied to make it stick, which was bad for it. The engine band wheel *G* was 10 ft. and the receiving pulley 8 ft. diameter. I had a 48-in. idler I put on, to be adjusted by screws to give the right tension and to be within 12 in. of the driving side when it was at its highest point of adjustment, as shown. This arrangement gave 6 ft. 4 in. more contact on *G* and 3 ft. 3 in. more on *H*—approximately 24.5 sq.ft. more contact surface than before—taking care of the full load with a comparatively slack belt.



IDLER APPLIED TO LARGE BELT

It makes a great difference in the friction and the life of a belt whether there is a tension of 400 or 800 lb. on it. Belts that are taken up with clamps are often pulled up without the exercise of good judgment or knowledge as to how much the actual strain is. There has recently been put on the market a compression scale

to be slipped on the long clamp bolt used to pull the ends of belts together for splicing, and as the nuts are tightened these scales register the actual strain in pounds upon each bolt and also show when the strain is equal on the two sides.

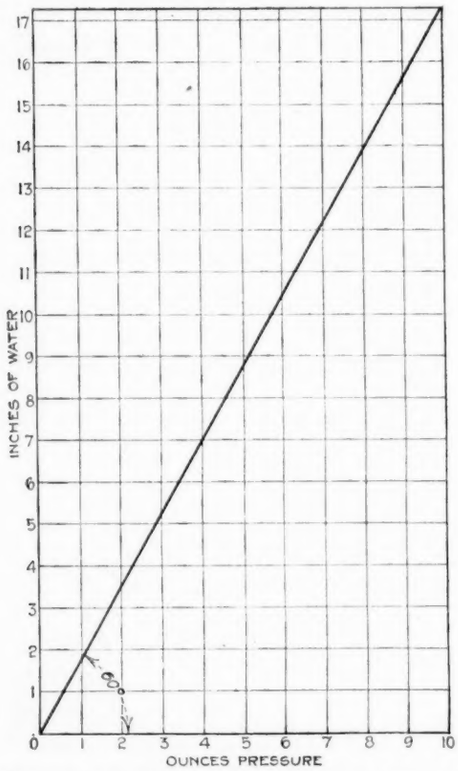
By the use of this device data may be kept so that when it becomes necessary to take up a belt positive directions may be given as to what tension is to be put upon it, thus avoiding overstrain and lessening the danger of hot bearings.

LEWIS F. LYNE.

New York City.

Ounces Pressure vs. Inches of Water

The accompanying diagram, which can be constructed easily with a 60-deg. triangle and a pair of dividers, or



INCHES OF WATER VS. OUNCES PRESSURE

a piece of cross-section paper, is based on the coincidence that 1 oz. pressure = 1.732 in. water and tan 60 deg. = 1.7321.

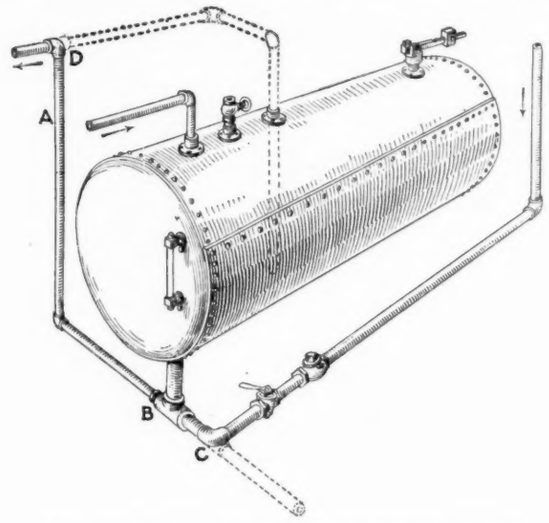
EDWARD C. SMITH.

Wichita, Kan.

Water-Supply System Piping

A 1,000-gal. tank in a greenhouse pneumatic water-supply system was formerly filled by gravity from a stream by opening the air vent to relieve the pressure and the plug-cock on the water-supply line. These were shut again when the tank had nearly filled, and the air pump then supplied the pressure to force the water out into the distributing system.

Increased demand made a constant supply necessary, and a gasoline-driven pump was purchased and connected to the system by breaking the elbow *C* and substituting a T, and the air pump was retained to furnish makeup air if the tank became waterbound. It was soon found that an even pressure could not be maintained on the water system with the new pump in operation, and water would come from the hose in spurts,



ARRANGEMENT OF PRESSURE-TANK PIPING

injuring the plants. The contractor sent a man, who put in a new discharge pipe by bolting a threaded boiler flange on the top of the tank, as shown by dotted lines. This pipe was connected to the system at *D*, and the old pipe *A* was moved back to *B* and the T plugged.

The trouble was at once removed, and the tank now acts as an air chamber to absorb the pulsations of the pump.

A. J. FOULDER.

Syracuse, N. Y.

Selecting the Cheapest Drive

With leather advancing in price, it is well to seek other substitutes in belt drives. Leather is the strongest, toughest and most durable substance known for most belt drives, but with proper care other materials, like canvas, cotton and woven beltings in general, are good and some say just as good as leather.

There is always a most economical combination in the long run, and that is the combination to seek, and that nowadays may be the woven brand of belting using large pulleys. But it should not be run at a speed greater than a mile a minute, and finger shifters should be avoided on a woven belt.

To find the cheapest combination choose for the calculation different pulley diameters, and as the larger the pulleys the more they cost and the less expensive the belt, at each step add the costs together and one of the sums will be found to be less than others. It will generally be found that the larger pulleys and the narrow belt will cost the least.

W. F. SCHAPHORST.

New York City.

The Speed of an Induction Motor is expressed by the formula

$$\text{r.p.m.} = \frac{120 \times f\,(1 - \text{slip})}{p}$$

where f is the frequency (cycles per second) and p is the number of poles. The average full-load slip varies from about ½ to 2 per cent. in the larger sizes to about 10 per cent. in the 5-hp. size.

Inquiries of General Interest

Back Pressure in Ammonia Coils—What back pressure is usual in ammonia coils in ice-making plants? W. O. B.

As the temperature usually is from 5 to 15 deg. F., the back pressures will range between 20 and 28 lb. per sq.in.

Power Developed with Increase of Speed and M.E.P.—If an engine running at 75 r.p.m. with a m.e.p. of 40 lb. develops 100 i.hp., what would be the power developed with 80 r.p.m. and 45 lb. m.e.p.? H. K. W.

The power developed would be directly as the r.p.m. and as the m.e.p., so that with 80 r.p.m. and 45 lb. m.e.p. the engine would develop $\frac{80}{75} \times \frac{45}{40} \times 100 = 120$ i.h.p.

Surface of Absorption Generator Coils—What unit surface per ton capacity is usually allowed for the generator coils of an absorption system? A. D. B.

The surface required varies chiefly with the steam pressure. Mark's Mechanical Engineers' Handbook, p. 1725, gives approximate area values for 60 deg. F. condensing and 0 deg. F. brine as 14 sq.ft. per ton for 5 lb. (gage) steam pressure, 10 sq.ft. for 20 lb. and 6 sq.ft. for 50 lb.

Chattering of Safety Valve—What causes hammering or chattering of a spring-loaded safety valve of a boiler? J. J. B.

Hammering or chattering may be due to having too great length of pipe connection for the safety valve or from employing a connection that is too small. Under these conditions, when the boiler pressure rises to the pressure at which the valve blows off, there could be a rapid alternation of lower and higher pressure in the connections. Chattering can usually be stopped by increasing the amount of blowdown.

Side Fire-Door for Return-Tubular Boiler—What advantages or disadvantages would there be in having the fire and ashpit doors of a return-tubular boiler placed in the side wall of the setting? G. L.

The only advantage would be in obtaining space for firing in a location where firing space is not available at the front end of the boiler. Leading disadvantages are weakening of the boiler side-wall construction and the loss of heat and difficulty of operation that would result from reflection and radiation of heat from the opposite furnace side wall.

Slipping and Noisy Driving Belt—For driving a belted generator about 60 hp. is transmitted by a 16-in. belt from a 5-ft. diameter pulley on the engine to a 36-in. diameter receiving pulley on a jackshaft with 19 ft. between centers. How can slapping and slippage of the belt on the engine pulley be prevented? C. S.

If the belt is put on with an ordinary amount of tension and the pull is on the under side, slapping and undue slippage on the engine wheel probably would be caused by irregular speed of the engine, requiring a heavier flywheel. Slapping of the belt also might be caused by unevenness or want of a greater uniformity in its flexibility.

Advantages of Two-Stage Air Compression—What is the advantage of two-stage over single-stage compression of air? M. B.

Two-stage compression is adopted for the purpose of cooling the air after partial compression (by the process known as intercooling) and the consequent reduction of volume of air required to be handled before the second compression. The advantages over single-stage compression are the saving of power and the avoidance of the high temperatures, thus permitting more satisfactory lubrication, less deposit of combustible material in the air receiver and pipes and reduction of the liability of fires and explosions.

Increase of Power Absorbed by Lineshaft—Where a 1⅞-in. lineshaft 125 ft. long, with the receiving pulley at one end, is well hung and in good alignment, would more power be required to operate a machine that takes 3 hp. if the machine is so placed as to be belted from the end of the lineshaft farther from the receiving pulley than if the machine is belted from a driving pulley very near the lineshaft receiving pulley? E. P. J.

More power would be required for operation of the machine when belted from the lineshaft at the end farther from the receiving pulley because the shafting would absorb more power on account of its greater tendency to become twisted out of line, thus bringing greater pressure on the bearings. But at ordinary speeds for lineshafting, if the transmission of only 3 hp. would not cause the shaft to become overloaded, the additional power absorbed by the shaft would be so small as to be practically negligible.

Removal of Oil and Foaming of New Boiler—Should not a new boiler be boiled off with caustic soda to remove oil left in the boiler by the boiler maker to prevent burning of the boiler and to remove cause for foaming? P. C.

Most boiler makers apply a steam test and subsequently a hydrostatic pressure test before making delivery of a boiler, and these are usually sufficient to remove harmful quantities of oil that may be left in the boiler during its construction. Foaming that generally occurs shortly after starting up a new boiler is often attributed to oil, but more frequently it is due to presence of dirt that has found its way into the boiler during its handling and setting and to the detachment of scale from the material of the boiler. The foaming calls for blowing off and washing out the boiler after a short run, and to make sure that any oil present is removed at the same time, it is a good plan to add to the first filling of the boiler about a pound of caustic soda per 10 hp. of its capacity.

Current of an Induction Motor—How can the current per terminal be calculated for a 500-volt, 25-hp., 3-phase induction motor operating under full load at 0.85 power factor? C. A. N.

The current per terminal of a 3-phase induction motor may be determined by the formula:

$$I = \frac{\text{hp.} \times 746 \times 100}{1.732 \times E \times \text{P.F.} \times \text{per cent. eff.}}$$

Where

I = The current per terminal;
hp. = The rated horsepower of the motor;
E = The volts between terminals;
P.F. = The power factor of the motor.

The per cent. efficiency for a motor of this size is about 88. Hence

$$I = \frac{25 \times 746 \times 100}{1.732 \times 500 \times 0.85 \times 88} = 28.8 \text{ amp.}$$

Operation of Four-Stroke-Cycle Diesel Engine—What is the difference between the method of operation of a four-stroke-cycle gas engine and a four-stroke-cycle Diesel engine? H. S.

In four-stroke-cycle gas engines of the ordinary explosion type, a mixture of gas and air is drawn into the cylinder during the suction stroke and compressed in the following stroke. The mixture is then exploded at nearly constant volume by external means (that is, by ignition) at the beginning of the third or working stroke, and the burnt gases are expelled from the cylinder in the fourth stroke of the cycle. In a Diesel engine working on the four-stroke cycle, in the first stroke of the piston the engine cylinder is filled with air drawn from the atmosphere into the cylinder. On the next stroke the air is compressed to about 500 lb. per sq.in., its temperature rising to between 1,000 and 1,100 deg. F. During the early part of the third, or working, stroke the fuel oil is injected into the cylinder above the piston by a blast of air which is at a higher pressure than that in the cylinder, and combustion takes place as the temperature of the compressed air is above the burning point of the fuel oil. At full load, injection is continued for about one-tenth of the stroke and during the period of injection, and for a short period thereafter, the oil burns at nearly constant pressure. Expansion then occurs, completing the work on the power stroke. Just before the piston reaches the end of its travel, the exhaust valve begins to open. In the final or fourth stroke the exhaust valve remains open and the burnt gases are expelled from the cylinder, completing the cycle of operations.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Effect of Sulphur in Rivet Steel*

By Dr. J. S. Unger†

SYNOPSIS—The paper gives the results of experiments made under the author's direction upon samples of rivet steel having a sulphur content varying from 0.030 to 0.180 per cent. The specimens were subjected to hot and cold bending, flattening and upsetting tests, were pulled apart, made up into riveted joints, etc., and the fact that there was six times as high a percentage of sulphur in some as in others made no apparent difference in their behavior. The specifications of the American Society for Testing Materials, the A. S. M. E. Code and of the Massachusetts Board of Boiler Rules allow 0.040 and 0.045 per cent. of sulphur, for firebox and flange steel respectively, the limit for phosphorus being 0.040 and for manganese 0.30 to 0.50 per cent.

Sulphur in steel, whether justly or unjustly, is held responsible for its bad working. As a result the specifications covering the allowable amount of this element have been gradually lowered until in certain cases below 0.030 per cent. is the limit demanded. It is very difficult to reach this limit, and when reached there is grave doubt in the minds of many whether the quality of the steel has not suffered by the excessive purification required to produce such results. The purpose of the experiments was to study the effect on the working and physical properties of rivet steel by gradually increasing the amount of sulphur until it had been raised to a point far above that usually found in such steel.

The steel used was basic openhearth of carbon, 0.09 per cent.; manganese, 0.43 per cent.; phosphorus, 0.012 per cent.; sulphur, 0.031 per cent. The sulphur content of certain ingots from this heat was increased progressively by adding weighed quantities of sulphur to these ingots, the additions being regulated to secure as near as possible a uniform increase of sulphur from one ingot to the next higher. The heating and rolling was done in the regular way and all ingots were treated alike. The finished ¾-in. diameter rounds were alike in every particular as regards composition, heating and rolling, except that they carried different amounts of sulphur. The rolled bars showed the following amounts of sulphur: 0.030 per cent., 0.060 per cent., 0.090 per cent., 0.140 per cent., 0.180 per cent.

The hot-working properties and some of the cold-working properties are shown in Fig. 2. In Fig. 1 are shown some tests made on three separate heats of steel with different sulphur contents. Tests were also made on bars riveted up at different driving temperatures. A study of the appearance of the tested samples shows little difference between the low-sulphur rivets and those containing six times as much sulphur.

To determine what might be expected of the rivets when in actual service, a number of bars were riveted together and in addition a number of angles, as shown in Fig. 3. These samples were then tested to destruction with the results shown in Table 1.

Both the tensile and shearing strengths decreased with the percentage of sulphur, the tensile nearly 13 and the shearing over 5 per cent. With the exception of the 0.090 sample in the shearing and of the 0.140 in the tensile tests, the diminution of strength was continuous.

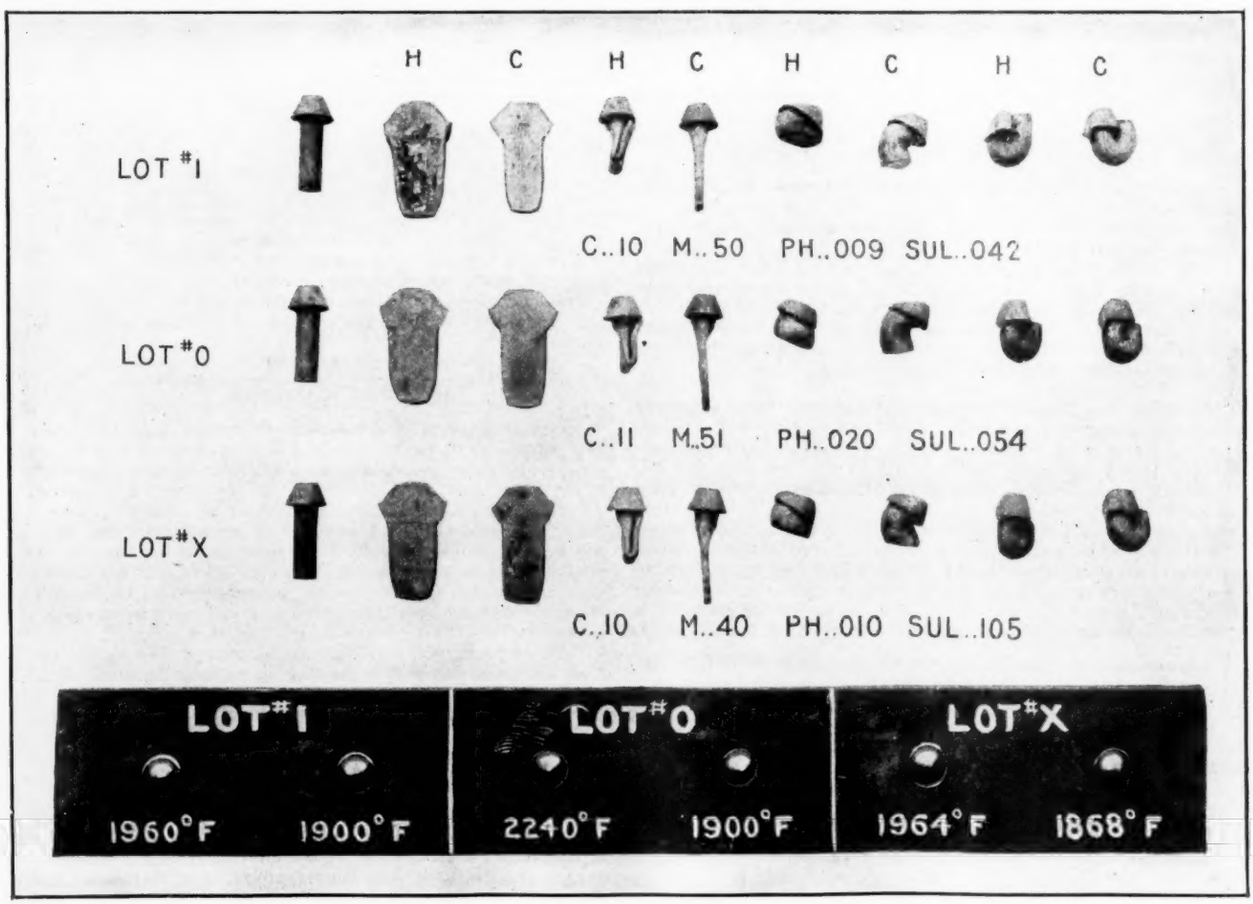


FIG. 1. TESTS ON THREE SEPARATE HEATS WITH DIFFERENT SULPHUR CONTENTS

*Abstract of paper presented at the Cleveland meeting of the American Boiler Manufacturers' Association, June 19.

†Director, research department, Carnegie Steel Co.

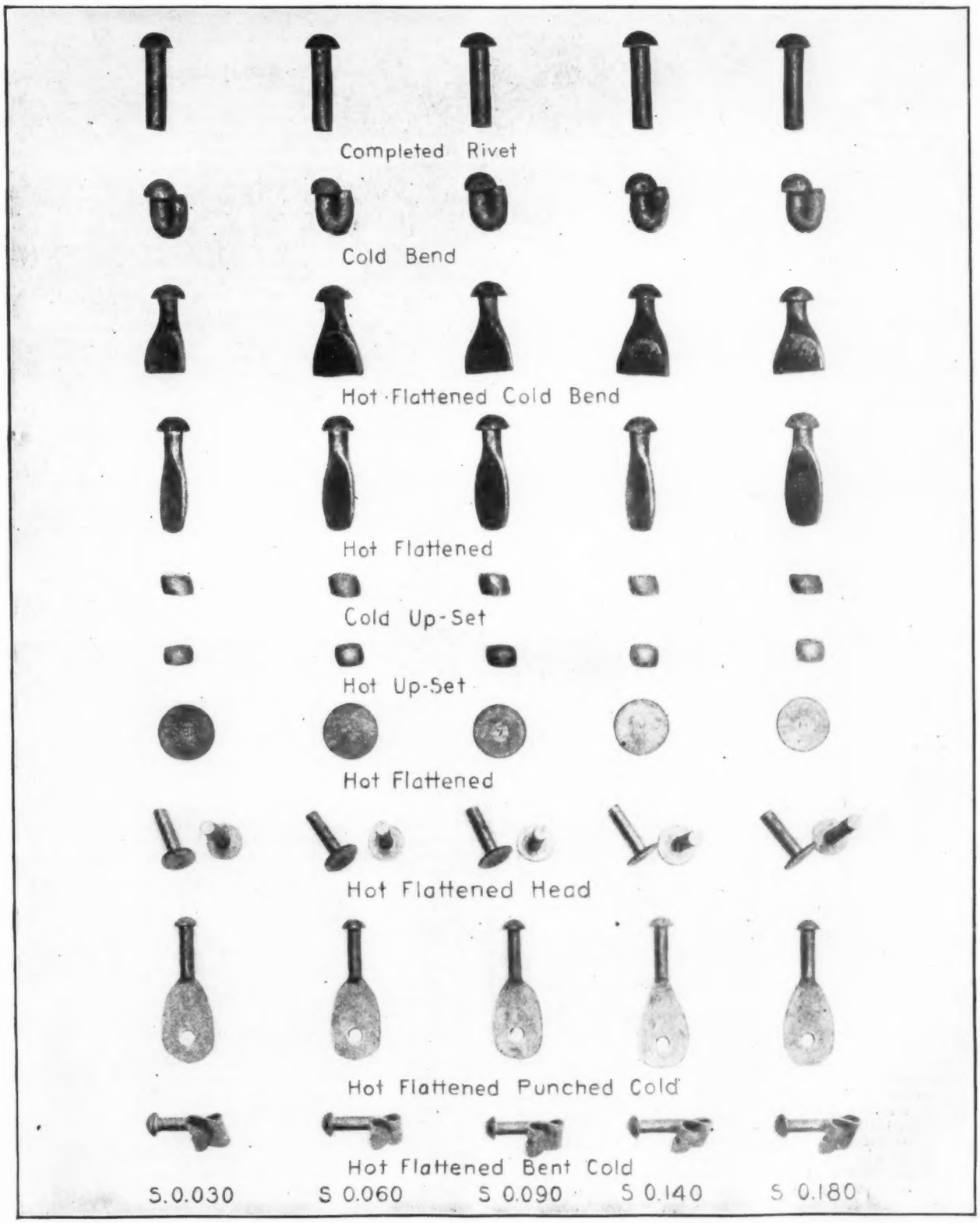


FIG. 2. BENDING AND FLATTENING TESTS OF RIVETS WITH VARIOUS PERCENTAGES OF SULPHUR

TABLE 3. TENSILE TESTS OF ¾-IN. RIVETS IN ORDINARY CONDITION AND QUENCHED

Sulphur Content	Elastic Limit, Lb. per Sq.In.			Ultimate Strength, Lb. per Sq.In.			Elongation in 8 In., %			Reduction of Area, %		
	a	b	c	a	b	c	a	b	c	a	b	c
0.030	34,010	44,100	32,700	51,740	69,700	50,630	34.2	8.1	23.0	70.2	62.5	61.5
0.160	32,820	44,450	31,060	51,050	71,160	50,400	34.6	9.8	25.0	70.4	62.7	59.4
0.090	37,480	54,690	33,430	51,620	76,600	50,140	36.0	7.6	32.8	67.3	53.7	59.2
0.140	34,320	49,380	32,060	50,320	70,520	49,500	33.7	11.1	32.0	67.1	58.3	60.8
0.180	33,340	43,730	32,200	51,050	67,850	50,510	37.4	10.6	34.0	65.8	54.8	60.4

(a) Ordinary condition. (b) Quenched in water from 1,200 deg. C. (c) Quenched in water from 350 deg. C.

TABLE 1. DESTRUCTION TESTS OF RIVETED JOINTS AND ANGLES

Sulphur Content	Riveted Joints, Shearing Strength	Riveted Angles, Breaking Load
0.030	48,900 lb.	33,240 lb.
0.060	48,300 lb.	32,000 lb.
0.090	48,800 lb.	30,000 lb.
0.140	46,700 lb.	31,200 lb.
0.180	47,400 lb.	26,180 lb.

The results of tensile and bending tests upon the rolled bars were as shown in Table 2.

TABLE 2. TENSILE TESTS OF ¾-IN. DIAMETER ROUNDS AS ROLLED—0.09 CARBON

Sulphur Content	Elastic Limit, Lb. per Sq.In.	Ultimate Strength, Lb. per Sq.In.	Elongation in 8 In., per Cent.	Reduction of Area, per Cent.
0.030	31,360	50,460	30.8	64.2
0.060	32,740	50,900	30.2	65.3
0.090	30,890	51,400	31.2	62.5
0.140	31,600	50,700	32.5	64.2
0.180	31,530	50,960	30.7	62.3

Tests were made on extra-long rivets under ordinary conditions to determine if one rivet head would stand as well as another. Nick bends were made, and the heads of the rivets were bent to see if any differences would be found in these cold bends, due to the varying sulphur contents. A similar set of tests was tried in which the rivets were heated to a

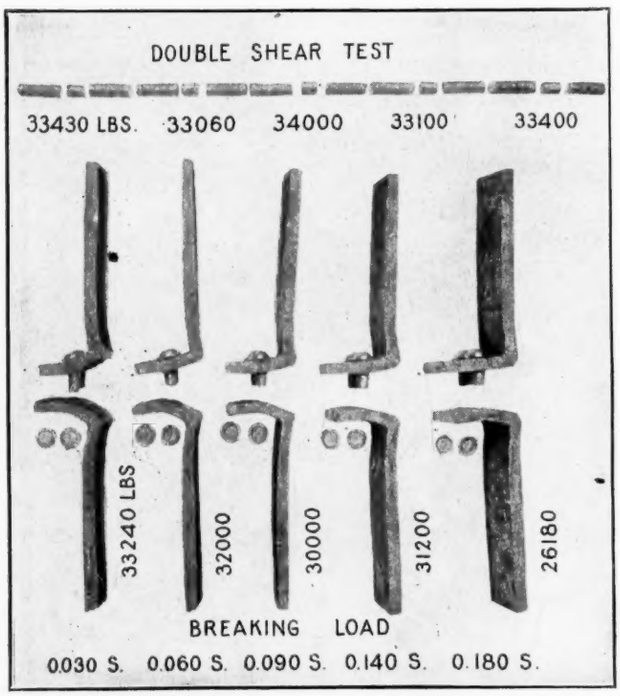


FIG. 3. SHEARING AND TENSILE TESTS

driving heat (1,200 deg. C.), then taken out of the fire and quenched in cold water to show the effect of drastic cooling from a high heat. A third set of tests was made on rivets that were heated to a blue heat (350 deg. C.), then quenched in cold water.

The object in all these tests was to show whether the different treatments affected the rivets differently and whether the higher sulphur rivets were affected to a greater degree than the lower sulphur. The results are given in Table 3.

In addition to these tests, a double shearing test was made on the ¾-in. rounds of each sulphur content in the ordinary condition. This test was made as shown in Fig. 3 and the shearing strength of each sample was as follows:

Sulphur Content	Shearing Strength in Lb., Double Shear
0.030	33,430
0.060	33,060
0.090	34,000
0.140	33,100
0.180	34,000

So far as the author has been able to determine, there does not appear, by working tests made on the finished rivet, to be any way of distinguishing between the quality of a rivet of 0.030 per cent. sulphur and one of 0.090 per cent. sulphur, if both have been subjected to the same conditions.

Examples of Boiler-Room Economies*

By Osborne Monnett†

The purpose of this paper is to select a few typical cases showing savings by the suppression of smoke.

Authorities agree that there is little combustible matter in the smoke itself—probably 1 or 2 per cent. of the fuel value is represented; so that suppressing the smoke and saving 1 or 2 per cent. would hardly be an item in the problem. The cases have been selected for the purpose of showing what other factors come into consideration when we save through suppressing smoke. Each case presented shows a different combination of circumstances under which a saving was made and which was due to other factors aside from the direct elimination of smoke.

Case 1—This was a plant having three return-tubular boilers with furnaces used in Chicago about six or seven years ago and known as the firebrick inclosed dutch oven flush front. The disadvantages of this furnace are that it insulates a large part of the surface of the boiler and imposes a heavy duty on the fire in maintaining a large quantity of brickwork at intense heat. This furnace was taken out and a more modern one put in, which exposed the heating surface directly to the fire and gave a high-temperature zone over the bridge-wall, the combustion being complete before the gases came in contact with the boiler surface. Before the alterations were made, the plant used 20 tons of coal in 24 hours at $3.25 a ton, making $65 a day fuel expenses. After the changes were made, the plant was operated on 15 tons at $2.25 per ton, or a total of $33.75, making a saving of $31.25 a day, or practically 50 per cent. Thus the alteration of the furnace design increased the heat absorption and enabled the burning of cheaper coal to carry the load.

In this case, as stated, the shell of the boiler was insulated from the hot gases, and in the second place the insulation not only decreased the capacity of the boiler, but decreased the efficiency, and it also imposed on the fire the additional responsibility of keeping the brickwork hot; but the great disadvantage from the smoke inspector's standpoint was the unsatisfactory smoke performance.

DISTILLATION OF VOLATILE DURING COMBUSTION

This type of setting brings up the question of hand-fired furnace design, and I have selected it for that reason. When we throw green coal on the fire, the heat underneath begins to distill the volatile matter from the coal. The volatile matter, as we all know, is what makes smoke, but in a dutch oven of this kind with red-hot brickwork above the fire, there is a secondary action when the intense radiation from the hot brickwork strikes the top of the fuel bed. This causes secondary distillation of the volatile matter, which aggravates the smoke performance.

Case 2—This was another dutch-oven class of furnace with full extension front, which had disadvantages not apparent in the first installation. A full extension furnace takes up more floor space, and the intense radiation from such a furnace is a direct fuel loss. In this instance there were four return-tubular boilers operating 24 hours a day. The dutch ovens were replaced by flush-front, double-arch, bridge-wall settings, the fire immediately under the boiler radiating directly to the heating surface. The saving in coal was 100 tons a month at $3, making a saving of $300 a month. There was no change in the character of the fuel.

Case 3—This was a typical No. 6, or double-arch, bridge-wall setting, as developed by the Chicago Smoke Inspection Department. This is a cool furnace, or direct radiating furnace, such as mentioned in case 2. The shell is exposed directly to the heat of the fire, increasing the heat absorption, and farther on behind the bridge-wall is the high-temperature zone which, in this case, is in a two-span butterfly arch with pier on the center and a deflection arch in one span behind the high-temperature zone against which the gases impinge, completing combustion.

The plant was a railroad roundhouse operating six boilers 24 hours a day. The boiler settings were in poor condition. Live steam was used in the stacks to create draft. After the stacks had been rebuilt, the leaks stopped in the settings, and a double-arch, bridge-wall furnace installed, there was a total saving of $800 a month, with no change in the character of the fuel. It is unnecessary to add that the owners and engineers of these plants were pleased with results.

---

*From the "Proceedings" of the Smoke Prevention Association.

†Former chief smoke inspector for Chicago, now low-pressure engineer with the American Radiator Company.

Case 4—This was a typical down-draft installation with return-tubular boilers. On a down-draft installation with a rate of combustion of approximately 25 lb. of coal per square foot of grate surface per hour, it is necessary to work the fire frequently to keep up steam. A peculiarity of the down draft is that the oftener you work it the more chance you have of making smoke. On a high-pressure power installation it has been found advisable to put some type of brickwork construction behind the bridge-wall to catch any excess of volatile matter and mix it with the air, which should be admitted on the bottom grate during the process of slicing the fire.

Originally there were four boilers on the line to carry the load. The plant was in continual difficulty, due to violations of the smoke ordinance. The trouble with the equipment was that the management was trying to burn too much coal and was allowing some volatile matter to pass off, making smoke. With a deflection arch and air admission on the lower doors it was possible to carry the load with three boilers, saving the radiation losses on that boiler and saving $1,500 a year in fuel.

Another similar case was that in which four boilers were used with the same type of equipment. Here the alterations consisted in putting in deflection arches behind two bridge-walls, air admission in the doors, 35-ft. extension on the stack and a smoke indicator. The figures for this plant after the changes were made showed a saving of 3 tons of coal per day at $2.65 per ton, or a daily saving of $7.95, making between $2,500 and $3,000 a year as the net saving.

Case 5—Here was a battery of three boilers of the Heine type, burning No. 5 washed coal (Illinois), which was used primarily because of smoke trouble. If the management got the No. 5 washed coal, it could carry the load and stay inside of the smoke ordinance, but in 1912 the coal strike came and No. 4 washed coal became necessary. This made more smoke, and it was found that the boilers would not carry the load and stay inside the smoke ordinance. Alterations were made as follows: The box tile was taken off the tubes over the fire for a distance of 4 ft. 10 in., admitting the heat of the fire directly to the heating surface. This increased the steaming capacity of the boilers. A 3-span deflection arch was put in so as to break up the current of volatile gases; air admission was provided in the firing doors, and the grate surface was shortened and widened so that there was the same amount of grate surface as before. But it is much easier to fire where the grate is shallow and wide than it is where the grate is long and narrow.

After the changes were made, it was found that the total saving was $3,800 a year, which saving was principally because one boiler would carry the load, whereas formerly one was under banked fire all the time that it was not in steaming service. Banked fire losses are usually quite an item.

Kentucky State Convention N. A. S. E.

The fourteenth annual convention of the Kentucky State Association of the National Association of Stationary Engineers was held June 27, 28 and 29 at Louisville. Headquarters, the Henry Watterson Hotel, was elaborately decorated with flags, streamers and bunting to greet the 200-odd delegates. At the opening session an address by Mayor John H. Buschmeyer was responded to by State President C. S. Moore, followed by J. J. Davis, representing the Louisville Board of Trade, and Arthur Kaye, manager of the Manufacturers' Exhibition of Louisville products, who invited all to visit the exhibition and partake of refreshments. John F. Hurst offered suggestions as to means for increasing the local membership and told of what had been done along that line during the last year.

Routine business consisting of reports of committees and the election and installation of new officers, was carried through expeditiously. The officers elected were: John F. Hurst, president, Louisville; James R. Morris, vice-president, Hopkinsville; George J. Jake, secretary, Hopkinsville; W. H. Elliott, treasurer, Louisville; T. A. Cassin, conductor, Central City; C. Carrol, doorkeeper, Louisville; C. S. Moore, state deputy, Lexington. The past president's jewel was presented to retiring president, C. S. Moore, by his successor in that office, John F. Hurst.

Several important papers were read during the various sessions, including the following: "The Future of the Isolated Plant," by George A Pardee; "Benefits of Membership in the N. A. S. E.," by John F. Hurst; "High-Pressure Boilers," by J. J. Niles (B. & W. Co.); "Lightning Protection Devices," by A. W. Lee; and "Sampling Coal Deliveries," by C. C. Harper, all of which showed that they had been carefully prepared.

The exhibit under the auspices of the Central States Exhibitors' Association occupied 40 booths (20 by local firms) and comprised all manner of power-plant appliances. It was opened by Past President Charles Cullon in the absence of President Charles H. Fiske. Delegates and friends were guests of the Exhibitors' Association Tuesday evening at an entertainment that was much enjoyed. The following active members were exhibitors at the convention: The V. D. Anderson Co., H. W. Johns-Manville Co., the William Powell Co., "National Engineer," Garlock Packing Co., Lunkenheimer Co., Dearborn Chemical Co., Hawk-Eye Compound Co., Crandall Packing Co., Jenkins Bros., Peerless Rubber Manufacturing Co., Keystone Lubricating Co., Edward Valve and Manufacturing Co., G. L. Simonds & Co., M. H. Detrick & Co., National Steam Pump Co., "Power," "Practical Engineer," "Southern Engineer." The associate members were Gunther & Hughey, Schaeffer & Budenburg Manufacturing Co., Merchants Ice and Cold Storage Co., H. Vogt Machine Co., Louisville Gas and Electric Co., Standard Oil Co., the Ahrens & Ott Manufacturing Co., National Foundry and Machine Co., P. A. Vogel & Sons, Andrew Cowan & Co., Laib Co., E. D. Morton & Co., Childers Electric Co., Jenkins Graphite Lubricating Co., W. R. Martin & Co., Henry Heick Hardware Co., Louisville Sanitary Wipers Co., Babcock & Wilcox Co., Western Valve Co.

The social and festive occasions consisted of an inspection trip to the plant of the Louisville Gas and Electric Co.; an evening with the Central States Exhibitors, Hotel Watterson; Wednesday afternoon at the exhibition of the Louisville Manufacturers and as guests of the Louisville Publicity League on inspection trip to the new canal locks in Portland, and in the evening a river trip on the steam "Queen City." Thursday evening up to 10 o'clock was spent in the exhibitors' hall listening to songs and instrumental music, after which an "Irish lunch and smoker" was given by the local entertainment committee and the exhibitors jointly.

The place for holding the next annual convention was left to the decision of State President Hurst and President Henchman, of the Central States Exhibitors' Association, to be selected not later than Jan. 1, 1917.

Expansion of Water Into Steam

The following is from D. K. Clark's treatise on the Steam Engine. In illustrating the subject a tall, vertical cylinder open at the upper end is used, in which a piston is inserted with a quantity of water at the bottom and a fire applied beneath to convert the water into steam, thus combining the boiler and engine in one vessel. The piston has a diameter of approximately 13½ in., making 1 sq.ft. of sectional area, and for simplicity it is assumed that it is without weight and frictionless.

A pound of water is put in the cylinder, taking up a little less than ½ of an inch in depth, and a fire is started under the water. Since the upper end of the piston is open, atmospheric pressure equal to 14.7 lb. per sq.in., or 2,116.8 lb. to the total area, acts on the piston. The temperature of the water under atmospheric pressure will be raised to 212 deg., when it will remain stationary, then steam will be generated, raising the piston against its atmospheric load of 2,116.8 lb. until a height of 26.36 ft. is attained; or in other words, the pound of water has evaporated into saturated steam at atmospheric pressure and occupies a space of 26.36 cu.ft.—as the area of the cylinder is 1 sq.ft. and the height 26.36 ft. The work done by the steam consists in having lifted a weight of 2,116.8 lb. through a distance of 26.36 ft., amounting to 55,798 ft.-lb.

Specifications for Locomotive Boiler Tubes

Seamless cold-drawn locomotive boiler tubes and safe ends shall be made of standard soft basic openhearth steel. Chemical anaylsis—sulphur and phosphorus not to exceed 0.04 per cent. Sample for chemical analysis to be taken by drilling several points around the circumference of the tube.

Inspection—Tubes shall have a smooth surface, be free from all injurious pits, checks, cracks or laminations, free from bends, kinks, buckles or other defects that would shorten their life or otherwise limit their usefulness. The thickness of the wall shall not vary more than 10 per cent. above or below the gage specified. Tubes shall be round within 0.02 in. The mean outside diameter shall not vary more than 0.01 in. from the size ordered. Tubes shall not be less than the length ordered nor more than 0.125 in. longer.

Physical Test—Ring Test: Coupons 1 in. long cut from a tube shall stand hammering down vertically into the shape of a ring without showing cracks or flaws when crushed of a ring without showing cracks or flaws when crushed flat.

Expanding Test—Sections of tube 8 in. long, with or without heating, shall be placed in a vertical position and a smooth tapered steel pin forced into the end of the tube. Under this test the tube shall expand to 1⅛ times its original diameter without splitting or cracking. The pin used for this test shall be of tool steel and have a taper of 1½ in. per foot in length. When this test is made hot, the tube shall be heated to a bright cherry red in daylight and the pin at a blue heat forced in as described.

Flanging Test—For tubes 1¾ in. diameter and larger, coupons 8 in. long, cut from the tube shall have a flange ⅜ in. wide bent over at right angles to the body of the tube without showing crack or flaw. For tubes less than 1¾ in. diameter, the width of flange shall be ⅛ of the diameter of the tube. All work to be done cold.

Flattening Test—A section 4 in. long shall stand hammering flat cold until the inside walls are in contact, without cracking at the edges or elsewhere. Two tubes to be tested as required under physical test in each lot of 250 tubes or less. If only one of the tubes so tested fails, that tube will be rejected and the inspector will take two more tubes from the same lot and subject both to the same test. Both of these must be found satisfactory in order that the lot may be passed.

Internal-Pressure Test—Each tube must be subjected by the manufacturer to an internal hydrostatic pressure of 1,000 lb. per sq.in.

General Requirements—In addition to the foregoing tests, tubes when inserted in boilers must stand expanding and beading without showing crack or flow. Each tube must be plainly stenciled "Shelby Seamless Cold-Drawn Tested to 1,000 Lb.," and tubes must be so invoiced.—National Tube Company.

Larger Oil Production Expected for 1916

The quantity of petroleum marketed in the United States during the first half of 1916 is estimated by John D. Northrop, of the United States Geological Survey, at 140,000,000 bbl. His estimate is moderate and his apportionment of the output among the major fields is as follows:

Field	Barrels
Appalachian	11,400,000
Lima, Ind.	1,800,000
Illinois	7,900,000
Kansas and Oklahoma	50,500,000
Northern and central Texas	4,200,000
Northwest Louisiana	6,800,000
Gulf Coast	11,400,000
Wyoming and Montana	2,400,000
California	43,500,000
Miscellaneous (Colorado, Michigan and Missouri)	100,000
Total	140,000,000

This quantity, which includes a little oil actually produced in 1915 but marketed during 1916, is appreciably less than the output during the first half of 1915, though it is greater by about 5,000,000 bbl. than one-half the entire quantity marketed last year. When it is considered that the first half of 1915 includes the period of maximum production of the Cushing pool in Oklahoma and the Crichton pool in northwestern Louisiana, the disparity in output between the corresponding periods is not especially significant. The magnitude of this quantity, the fact that it is greater than one-half the total petroleum marketed in the United States in 1915, and the further fact that it reflects the results of general activity throughout all oil-producing areas rather than flush production in restricted areas is, however, significant and leads to no other conclusion than that the final statistics of oil marketed in 1916 are destined to establish a new record.

The outstanding feature of the petroleum industry during the half-year just closed was the high level reached in the prices of crude oil in March and maintained firmly to the end of the period. This level involves prices ranging from 90 to 350 per cent. higher than those of a year ago for high-grade Eastern and Mid-Continent grades and reflects less strongly the decreased capacity of Cushing than it does the increased demand for crude oil resulting from the activity of a large number of new refineries installed during the recent period of low prices.

New England N. A. S. E. Meet at Fall River

The annual convention of the New England States Association of the National Association of Stationary Engineers was held in Fall River, Mass., July 12-15. The Wilbur Hotel was the headquarters, but the attendance was so large that many of the visitors were compelled to seek quarters in other hotels and at private residences. The sessions of the delegates were held in Anawan Hall, an easy walking distance from headquarters, while the mechanical exhibit occupied the drill room of the armory, conveniently located. There were over 100 delegates present, and the mechanical display covered 107 booths.

DELEGATES AND GUESTS AT THE NEW ENGLAND STATES

The exhibition was formally opened on Wednesday evening with a short program of exercises. Major James W. H. Myrick, president of the New England Association of Commercial Engineers, occupied the chair and opened his speech by saying: "If I had the choice of 100 men of any one class or trade to command, I would choose the engineer. He is never late, never watches the clock and never washes up a half-hour ahead of quitting time. The engineer must have a good foundation, and when he receives his papers from the commonwealth they stand for thought and hard work. After his six days of from ten to twenty-four hours he comes down to the plant on Sunday to pack a valve or fix an elevator, and it is the engineer who must get the B.t.u.'s from the coal pile to make the dividends." Then followed the addresses of Mayor James H. Kay, of Fall River; Harry P. Brown, of the Chamber of Commerce; John R. Graham, chairman of the local committee; Albert C. Ashton, past president of the New England Association of Commercial Engineers; and Fremont S. Eggleston, Jr., secretary of the same association.

The opening ceremonies of the engineers was held in Anawan Hall on Friday morning, John R. Graham, presiding. Mayor James H. Kay told of the beauties of the city and how pleased he was to have the engineers' convention at Fall River for the third time. Riley Daniels, president of the New England Association of Stationary Engineers, fittingly responded for the engineers. Thomas E. Leahy, of the Chamber of Commerce, spoke of the manufacturing interests of the city

with its 115 mills and many other industries. National President Walter H. Damon thanked the mayor and Mr. Leahy for their kind welcome and told of the good qualities of the N. A. S. E. Other speakers included William K. Campbell, past president of the N. E. A. C. E., who spoke in behalf of the supplymen; John T. Maloney, another past president of the N. E. A. C. E., who spoke of the early days of the N. A. S. E. in Massachusetts; and James D. Taylor, who told of the benefits of the Life and Accident Department connected with the N. A. S. E.

P. H. Hogan was introduced and gave a brief history of the New England Association of Stationary Engineers. President Riley Daniels appointed the several committees and the meeting adjourned until the afternoon session.

On Friday evening a smoker was held in Anawan Hall, with Sanford C. Smith, of the McClave-Brooks Co., acting as the toastmaster. The talent was introduced in the order named and included Alvin Connors, pianist; Herbert Self, Peerless Rubber Manufacturing Co.; Joe McKenna, Jenkins Bros.; Isaac Robinson, cornet solo; Jack Armour, "Power"; and Monroe Silver, parodies. During an intermission Riley Daniels was presented a diamond scarf pin from the engineers and Major Myrick received a gold watch, the gift of the supplymen.

On Saturday morning an auto ride was taken through interesting parts of the city, complimentary to the convention by the Chamber of Commerce, and on Saturday afternoon special cars conveyed the company to Stone Bridge, where an old-fashioned clambake was served.

At the closing meeting the chairman of a committee from the Connecticut State Association read a resolution desiring amalgamation with the New England body. The resolution was unanimously adopted. The following officers were elected: John Quinn, Holyoke, president; Joseph Eccleston, New Bedford, vice-president; James H. Henderson, Boston, secretary; Walter H. Damon, Springfield, treasurer; Andrew White, Portland, conductor; D. N. Dolbear, Norwich, doorkeeper. After a close vote with Bridgeport it was decided to hold the next annual convention in Portland, Maine, in July, 1917.

The New England Association of Commercial Engineers at their meeting on Friday afternoon elected the following officers for the ensuing year: Fremont S. Eggleston, Jr., president; John A. Moorehouse, vice-president; James W. H. Myrick, treasurer. For directors for three years: Charles B. Burleigh, Harry M. Colby and P. H. Hogan. The resolution from the Connecticut State Association for amalgamation with the N. E. A. C. E. was unanimously adopted.

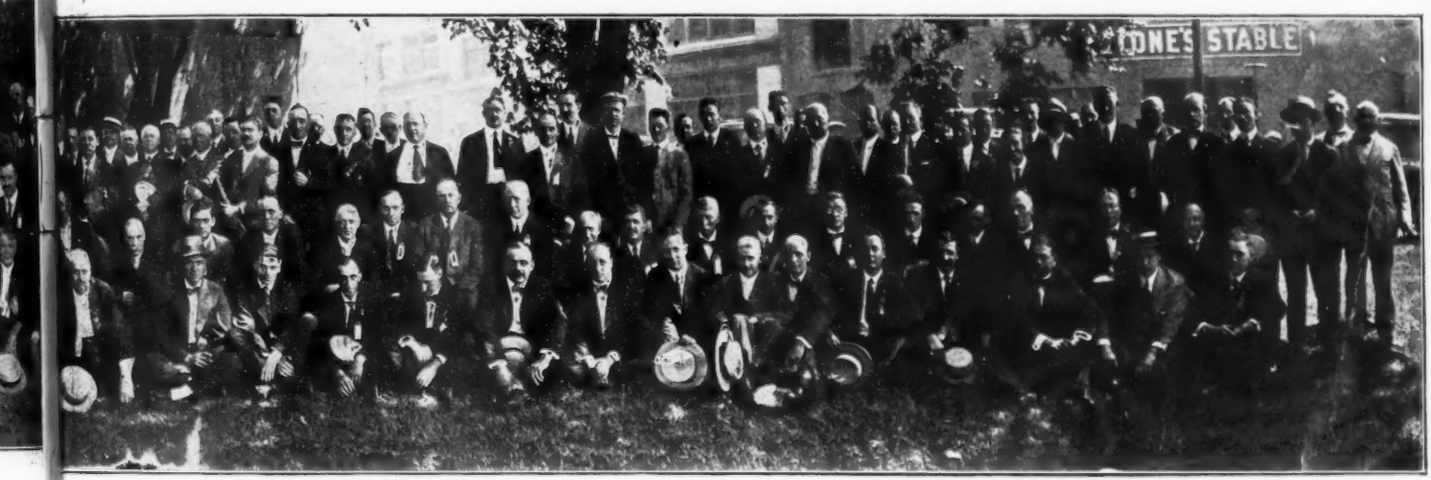
MAJ. J. W. H. MYRICK

The Efficiencies of Some Large Turbines

In the June 6 issue of "Power" there was given a brief description of a 35,000-kw. General Electric turbine for the Boston Elevated Railway Co. The Rankine-cycle efficiency ratio was given as 63.44 per cent. instead of 76.44 per cent.

The lowest guaranteed steam consumption of this turbine is 10.65 lb. at 25,000 kw., 200 lb. gage pressure, 200 deg. F. superheat and 1-in. back pressure, and this consumption was mentioned as the lowest that had come to our attention. Interest in the performances of large turbines is general, and a more elaborate comparison of the Rankine-cycle efficiency ratio of this machine with the 30,000-kw. cross-compound units in the Seventy-fourth Street power house of the Interborough Rapid Transit Co. is of interest.

In the report of tests of these units given in a paper by H. G. Stott and W. S. Finlay before the American Society of Mechanical Engineers, the highest Rankine-cycle efficiency ratio given was 75.8 per cent. But if the steam pressure were reduced to 200 lb. gage and the superheat increased to 200 deg., making the conditions the same as for the Boston machine, the steam consumption would be 10.55 lb. per kw.-hr. and the Rankine efficiency ratio 77.2 per cent., at 26,700 kw.



N. A. S. E. ANNUAL CONVENTION, FALL RIVER, JULY 12 TO 15

Massachusetts Boiler Bill Killed

Friends of the Board of Boiler Rules in Massachusetts will be glad to learn that Senate Bill No. 521, which aimed to abolish the office of the deputy chief of the Boiler Inspection Department and to create the office of chief inspector of the Boiler Inspection Department, was summarily rejected. This bill aimed at legislating out of office the present incumbents. According to it, all citizens over 45 years of age were eligible for examination. This age limit excluded the chief and other inspectors of the department. The bill, as presented, provided that no preference should be given because of experience in the field of work which the department performs. This bill is one of three or four that have been introduced within the last year or two to disorganize the Board of Boiler Rules.

MISCELLANEOUS NEWS

Sioux Falls, S. D., is to have an electric-light system installed by the Northern States Power Co. Walter C. Leyse is the city auditor.

New Power Plant on Dix River, Ky.—Ground has been broken near Kennedy's Mill on the Dix River, Garrard County, Ky., for the dam which is to be the nucleus of a power plant to supply electricity to Lexington, Richmond, Danville, Harrodsburg, Nicholasville, Lancaster and other central Kentucky cities. Louis B. Herrington, of Richmond, is representing New York capital and is supervising construction. An industrial

city will be built and work prosecuted vigorously. The project has been under consideration for four or fire years, and the water gage has been in operation for that time. It is expected that the plant will cost in excess of $3,000,000.

The J. G. White Management Corporation, of New York, has been retained as operating manager of the Shore Line Electric Railway System and the Norwich & Westerly Traction Co. The combined property operates 250 miles of interurban electric trolley lines, serves all the towns and shore resorts on Long Island Sound east of New Haven, and continues the service from New London, Conn., through Westerly, R. I., to Watch Hill, Atlantic Beach, Weekapaug and other resorts on the Atlantic Ocean.

The Commissioners of Shawano, Wis., are planning to have constructed a power house and dam. The dam is to have a 230-ft. spillway. Henry E. Schuster is one of the commissioners.

New Hydro-Electric Plant in Vermont—A company to be known as the Central Power Corporation of Vermont has been granted permission by the Public Service Commission of Vermont to build a hydro-electric power plant at the Gorge on the Middlebury River. No particular plan of development has been proposed by the commission; this will be passed upon later.

PERSONALS

H. O. Swoboda has been retained as consulting engineer by the Borough of Monaca, Penn.

G. W. Bonnell, for a number of years associated with the Underfeed Stoker Co. of America, has joined the staff of the Moloch Stoker Co., Chicago, in the capacity of vice-president and chief engineer.

Herman Nieter, formerly sales manager for the Kennicott Co., Chicago, and later manager of the New York office of the Blaw Steel Construction Co., is now with the American Spray Co., 26 Cortlandt St., New York, as sales engineer.

Walter N. Walmsley has been appointed general manager of the Alabama Power Co. to succeed F. H. Chamberlain, who has resigned. Mr. Walmsley has had much experience in handling large construction and development work in both the United States and South America.

Walter N. Polakov, recently superintendent of power for the New York, New Haven & Hartford R.R., consulting engineer to the Board of Estimate and Apportionment of the City of New York, has been appointed vice-president to direct the local work of David Vershbinsky, Inc., 31 Nassau St., New York City, engineers and exporters, with branches in London and Petrograd. At the same time he is continuing his private practice as consulting engineer for the management of power plants.

BOOKS RECEIVED

A HOME STUDY COURSE IN PRACTICAL ELECTRICITY. In three volumes. By W. H. Radcliffe. McGraw-Hill Book Co., Inc., New York. Leather; 5½x8½ in.; 749 pages; 454 illustrations. Price, $6.

POWER TRANSMISSION BY LEATHER BELTING. By R. T. Kent. John Wiley & Sons, Inc., New York. Cloth; 5¼x8¼ in.; 114 pages; 31 illustrations; tables. Price, $1.25.

NEW PUBLICATIONS

EXAMPLES IN MAGNETISM. Written and published by Prof. F. E. Austin, Hanover, N. H., 1916. Size, 4½x7½ in.; 90 pages; flexible binding. Price, $1.10.

This book was prepared with the idea that fundamental knowledge of a subject can best be acquired through the solution of carefully selected problems. The procedure is to follow the statement and explanation of the physical law by an example, containing the algebraical expression denoting the law, which is carefully worked out step by step. This, in turn, is followed by a problem of similar nature to which the answer is given, but which is not worked out. Next a problem is given, but without an answer. In this way it is hoped to train the student to reason correctly. Being intended for beginners in electrical engineering, the mathematics have been kept within the comprehension of the high-school graduate. The book is adapted more to classroom work than to home study.

CENTRAL STATION MANAGEMENT. By H. C. Cushing and Newton Harrison. Published by D. Van Nostrand Co., New York, 1916. Size, 4½x7½ in.; 397 pages. Price, $2.

The authors have succeeded in presenting in a most entertaining and instructive manner the essential problems that confront the central-station manager. These consist primarily in maintaining cordial relations with the public, expanding the business, operating the plants as efficiently as possible and netting a fair profit to the stockholders. In covering these points, the rate question is viewed frankly from several angles, new business, such as electric heating and cooking, signs and factory loads, is discussed, and economical plant operation is covered in so far as will enable the manager to intelligently confer with his engineering force as to the elimination of waste and bettering the service. The book is well worth the attention of all central-station managers.

THE DIESEL ENGINE IN PRACTICE. By J. E. Megson and H. S. Jones. Published by the Technical Publishing Co., San Francisco, Calif., 1916. Size, 4½x6½ in.; 136 pages; flexible binding.

A handy little book containing a brief history of the Diesel engine, a description of the cycle upon which it works, some experiences with early installations, some of the types now being built in this country, particularly those exhibited at the Panama-Pacific Exposition, and a chapter on the operation and care of Diesel engines. As stated by the authors in the preface, the real object of the book is to give engineers the benefit of many years of practical experience in operating Diesel engines. In view of this the reader will be somewhat disappointed to find less than eighteen pages devoted to this important topic.

TRADE PUBLICATIONS

Oil Engines. Fairbanks, Morse & Co., Chicago, Ill. Bulletin H192C. Pp. 8, 6x9 in. Illustrated. Confined to the Type Y, Style V oil engines.

Old Engines, Semi-Diesel. Fairbanks, Morse & Co., Chicago, Ill. Bulletin H178B. Pp. 4, 6x9 in. Illustrated. Covers the Tye Y semi-Diesel oil engines.

Leather, Leather Belting, Belt Dressing, Packings, Etc. Graton & Knight Manufacturing Co., Worcester, Mass. Catalog No. 6. Pp. 120, 6x9 in. Illustrated.

Crude Oil Engines. De La Vergne Machine Co., Foot East 138th St., New York. Bulletin No. 154. Pp. 4, 8½x11 in. This shows new sizes of Type FH engines up to 1,200 hp.

Steam Soot Blower. Bayer Steam Soot Blower Co., St. Louis, Mo. Bulletin No. 135. Pp. 16, 6x9 in. This illustrates and describes Type F blowers for horizontal fire tube boilers.

Motors with Commutating Poles. C & C Electric and Manufacturing Co., Garwood, N. J. Bulletin No. 102-X. Pp. 8, 8x10½ in. Illustrated descriptions of Type "IB" motors with commutating poles.

Water Softening—The Permutit Co., 30 E. 42d St., New York. Booklet. Pp. 24, 6x9 in. This illustrates and describes the Permutit water softening process (claimed to reduce the hardness to zero) for industrial, textile and boiler plants, etc.

Texaco Crater Compound. The Texas Co., 17 Battery Place, New York. Pamphlet. Pp. 32, 6x9 in. This shows examples of the services to which this compound is adapted and will suggest means of meeting the difficulties of heavy gears and bearings in situations exposed to water and excessive heat.

The Ingersoll-Rand Co., 11 Broadway, New York, has issued a catalog in Spanish under the title "Productos de la Ingersoll-Rand." This is attractively and substantially bound and contains 124 pages replete with illustrations, descriptive matter and tabulated data. It covers completely the company's line of air and gas compressors, vacuum pumps, reciprocating and centrifugal water pumps, rock drilling, metal and coal mining, prospecting and quarrying machinery and pneumatic tools for machine and boiler shop and foundry work.

Classified Ads

appear on pages 78 and 79 of this issue and will in future appear in the same relative position in the paper. Page numbers will be given in the Table of Contents under the heading "Special Opportunities Section."